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## CONGENITAL ANOMALIES OF THE DUODENUM WITH OBSTRUCTION AT THE DUODENOJEJUNAL ANGLE*

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PARTIAL or complete obstruction of the duodenum at the duodenojejunal angle, resulting from a congenital anomaly, is exceedingly rare. The condition is usually found at necropsy rather than at operation. A review of the records of The Mayo Clinic disclosed only two such cases. They are reported herewith.

REPORT OF CASES.—CASE I.—The patient, a man aged nineteen, the fourth child of healthy parents, born at full term, and breast fed, was perfectly well and developed normally until the age of two years, at which time attacks of abdominal pain appeared. The mother did not recall that the patient ever had had difficulty prior to the time of weaning. The pain occurred at intervals of from two to three weeks and was quite generalized, varying in intensity and beginning very soon after the ingestion of food. It was frequently associated with vomiting, which occurred from a few minutes to several hours after meals and in all instances afforded considerable relief. Often vomiting was induced, the patient finding that he derived immediate benefit by emptying his stomach. Certain foods did not seem to be a factor in precipitating the pain. Any food or even fluid caused the distress to persist during an attack and the patient had made it a practice to defer eating until all pain had subsided; otherwise the disturbance might last over a period of two or three days. May 24, 1927, the patient had the most severe attack since the onset of his illness. At that time the appendix was removed. The surgeon reported that the appendix was normal but was on the left side; he believed that all the abdominal viscera were congenitally on the left side, and that this anomaly was responsible for the attacks. One week after the operation the patient had an attack in all respects identical with the previous ones. He was unable to eat on account of the constant distress, with the result that he lost twenty-five pounds. Before coming to the clinic he was kept on a strict milk diet, with complete rest in bed for a period of a month without any benefit. In spite of his handicap the patient had been able to attend school and to do a moderate amount of light work during vacation.

The general examination was essentially negative except for marked emaciation. Röntgenograms of the stomach were negative. A pre-operative diagnosis of chronic intermittent intestinal obstruction (congenital anomaly) was made.

Exploration revealed chronic intestinal obstruction due to congenital malformation of the small intestine apparently at the duodenojejunal angle. The duodenum was dilated to about three times normal size; the distal half was completely covered with peritoneum

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and possessed a short mesentery. There was a very firm band 7.5 cm. wide extending from the root of the mesentery across the duodenojejunal flexure and becoming continuous with the posterior leaf of the transverse mesocolon (Fig. 1). This band held the bowel fixed at this point and produced partial occlusion. The root of the mesentery,
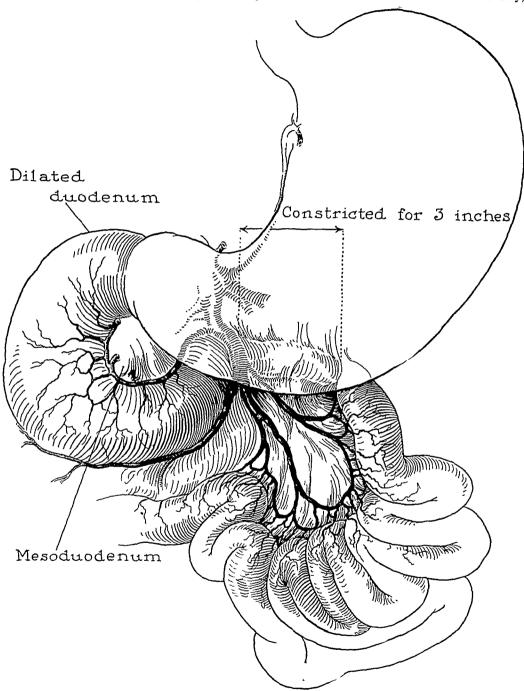


Fig. 1.—Dilated duodenum, due to obstruction produced by a peritoneal band 7.5 cm. wide extending from the root of the mesentery up across the duodenojejunal angle. Marked dilatation of the superior mesenteric veins may be noted.

instead of having its normal attachment to the posterior abdominal wall, along a line drawn from the left of the spine down to the right iliac fossa, seemed to be attached to a limited area anterior to the second lumbar vertebræ, being pedunculated as it were. The superior mesenteric veins were markedly dilated. Both the size and

position of the large intestine were normal, but the cecum and ascending colon possessed an abnormally long mesentery, thus allowing free motion of that part of the bowel. The peritoneal band was separated, freeing parts, but not releasing the obstruction entirely. Therefore a lateral anastomosis was made between the duodenum and the loop of the jejunum just below the point of obstruction (Fig. 2). The post-operative convalescence was uneventful. The patient has been free from symptoms for one year.



FIG. 2.—Anastomosis of the dilated duodenum to the jejunum just below the site of obstruction.

CASE II.—A woman, aged nineteen, came to the clinic, September 22, 1920, complaining of abdominal cramps of several years' duration. As far back as she could remember she had had attacks manifested by severe pains in the umbilical region, limited to an area 10 cm. in diameter, slow in onset, most marked after meals and lasting for from seven to ten days. Vomiting afforded some relief. Until two years before examination an average of two attacks had occurred yearly; they then became more frequent (every two months) and more severe, requiring morphine for relief. She finally

reached the stage where she was afraid to eat because of the possibility of precipitating an attack. The appendix had been removed in January, 1919, without benefit.

The general examination was essentially negative. Gastric analysis was negative. Röntgenograms of the stomach and colon were negative. The small bowel was empty at sixteen hours. Repeated examinations of the stools were negative for ova and parasites. The diagnosis was indeterminate, and exploration was advised.

The pelvic organs, kidneys and ureters were normal. The spleen was of normal size. There was no evidence of Meckel's diverticulum. The gall-bladder, ducts and pancreas were normal.

The duodenum was the only part of the small intestine which was distended and hypertrophied; it did not rotate up behind the stomach but came directly and obliquely downward and was compressed over the vertebræ by the weight of the mesentery of the small intestine. Instead of presenting on the left side of the vertebræ, the jejunum began in front and on the right side of the vertebræ. The peritoneal fold was divided in order to give a larger opening as the retroperitoneal portion of the duodenum became the jejunum. It was felt that the liberation of the constricting bands was sufficient to relieve the partial obstruction, although duodenojejunostomy might be necessary later. The immediate post-operative convalescence was uneventful, but the ultimate results were only fairly satisfactory.

CASE LITERATURE.—At a meeting of the Royal Academy of Medicine, in 1826, BARON exhibited the digestive canal of an infant that lived three days. The duodenum was much dilated and terminated in a cul-de-sac which became entirely obliterated where it joined the jejunum. The jejunum formed an extremely narrow canal of the size of the urethra ending in the cecum, and the large intestine scarcely presented the caliber of the duodenum.

CARLING reported a case of congenital stricture at the duodenojejunal angle in a married woman aged forty-seven. Frequent attacks of pain in the left hypochondriac and umbilical regions associated with copious vomiting had occurred six months previously. The pain came fifteen minutes after meals, and vomiting always afforded relief. At operation the duodenum was found to be greatly distended due to obstruction just below the jejunal flexure. Resection and lateral anastomosis were carried out. An uneventful convalescence followed. On examination of the specimen removed, a stricture was found which admitted only a very small probe. There was no evidence of malignancy or of an inflammatory process. The author concluded that the anomaly was purely congenital.

DENZER reported on the examination at necropsy of an infant twenty-six days old. The stomach and duodenum were dilated; the third portion of the bowel, instead of curving gradually upward, turned acutely to the left, creating a sharp duodenojejunal angle and producing obstruction. The jejunum just below this angulation emerged, clamped between the last few inches of the ileum dorsally, and the cecum and ascending colon ventrally. This was due to the fact that the cecum and ascending colon were held up to the root of the transverse mesocolon by an abnormal peritoneal attachment.

FREEMAN reported a case of a long U-shaped duodenum with a kink and a constriction at the duodenojejunal juncture. In this case the duodenum, instead of appearing in the abdominal cavity from beneath the transverse mesocolon to the left of the spine and being fixed retroperitoneally as it should, emerged to the right, its transverse and ascending portion possessing a peritoneal covering and mesentery of its own similar to the remainder of the small intestine. At the duodenojejunal angle, however, the bowel was attached to the root of the transverse mesocolon by a firm adhesion (duodenal fold of fetal life), the kink thus produced being intensified by the downward pull of the free duodenal loop.

MOORE described a specimen from a man aged forty in which there was a congenital stricture at the duodenojejunal angle, and three diverticula in the first three feet of the

small intestine. The narrowing at the jejunal flexure was caused by an internal ring of mucous membrane which would just admit the little finger.

SPRIGGS reported data on the examination at necropsy of an infant fourteen days old. The duodenum was dilated to the size of the stomach, due to congenital stenosis at the duodenojejunal angle. The stricture was slit-like and scarcely admitted a fine probe.

THOMAS reported on the examination at necropsy of an infant seven months old. The duodenum was dilated and occupied the greater part of the abdominal cavity, terminating on the left side of the spine in a blind extremity. There was no trace of any part of the small intestine and proximal half of the colon.

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# ATRESIA OF THE DUODENUM AND DUODENAL DIVERTICULA

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IN THE following paper two anomalies of the duodenum are presented together. Although they are apparently different in type, certain facts and their ontogenetical interpretation point to the possibility of a similar origin.

The first case, that of *atresia of the duodenum,* was found in a male child, born on March 31, 1928.

Condition at birth apparently normal, although underweight, five pounds, eight ounces. Baby lived five days and during this time the outstanding symptoms were continuous vomiting which developed soon after birth, jaundice, progressing emaciation, and no passage of meconium. Diagnosis of intestinal obstruction was made and operation resorted to.

Operative findings: Laparotomy, peritoneum covered with sanguinous exudate, stomach and duodenum enormously distended and latter ending in a blind pouch. Small intestine's upper end was also closed and its entity collapsed and under-developed. No possibility for any surgical procedure. Abdomen closed. The child died April 5. Weight at death four pounds, three ounces.

*Autopsy.*—Poorly developed and considerably emaciated male, white child. Skin and visible mucous membranes yellowish. In abdomen was found some fluid blood and clots, the retroperitoneal connective tissue, omentum and mesentery infiltrated with blood. Liver, medium size; bile ducts, patent. Stomach, normal shape but somewhat distended, pylorus slightly contracted but patent. The duodenum was enormous, its volume exceeding that of the stomach several times, it was horse-shoe shaped and at the place where it should have continued into the jejunum it ended abruptly. The whole small intestine as well as the colon were completely collapsed. Other abdominal organs and mesenterium were normal.

*Pathological Diagnosis.*—Congenital malformation of the intestines, atresia of the duodenum, multiple peritoneal adhesions, intra-abdominal hæmorrhage, jaundice, uric acid infarctions of the kidneys.



FIG. 1.—Atresia of Duodenum. A, Stomach; B, Duodenum; B₁, closed end of Duodenum; C, closed upper end of Jejunum.

The second case was that of a *duodenal diverticulum,* found in a white, male patient, age fifty-seven.

Patient admitted May 2, 1928. Died June 2, 1928. Emaciated and anæmic, complained of dizziness, weakness, and of pain in the upper abdomen during the last eight years. Intermittent hematuria for the last year. His stomach trouble he localized in the left upper quadrant following ingestion of meals, explaining that pain would come on soon after eating and last an hour, relieving itself without medication. Suffered with vomiting for a number of years but this condition subsided when the pain began eight years previously. Later, the pain was experienced all over the abdomen. Accompanying constipation. One sister and two brothers died of "constipation." Lost thirty pounds in the last two months. Main points in the physical examination were: Tenderness in the left upper quadrant and marked fulness in right upper half of the abdomen. In right hypochondrium, a firm and tender mass extending down to one finger's breadth below umbilicus and to the flank. Mass moved on respiration and had below a projection which corresponded to the kidney. Edge of the liver could not be made out because of its continuity to this mass. Liver extended to the left side across the epigastrium. Tenderness on pressure in right lumbar region. Few small inguinal glands.

*X-ray and Cystoscopic Diagnosis.*—Malignant growth of the right kidney.

*Blood Chemistry.*—Urea nitrogen, 20; creatinin, 1.9; glucose, 345; icteric index, 6.8; Wassermann, negative.

*Operation.*—Nephrectomy. During the course of this operation, because of the dense adhesions surrounding the tumorous kidney the enucleation was very trying and the peritoneum suffered a rent. Before inserting drains this rent was sutured and then the wound closed.

*Autopsy.*—E m a c i a t e d, elderly, white male. Acute purulent peritonitis, œdema and emphysema of the lungs, incipient cirrhosis of the liver, chronic swelling of the spleen with acute septic softening. Distention of the stomach and the duodenum. Duplex diverticulum of the duodenum, thrombosis of a branch of the pulmonary artery.



FIG. 2.—Diverticule of Duodenum. A, Pylorus; B, Diverticulum; C, Jejunum; D, Pancreas.

Microscopical examination of the kidney tumor proved to be a squamous-cell carcinoma, which apparently derived from the pelvic mucous membrane.

*Detailed Description of the Stomach and Intestines.*—Stomach considerably distended, its mucosa smooth and covered with mucus. Right below the pylorus the duodenum showed a diffuse dilatation with a marked bulging toward the liver. There were two diverticula in the wall of the duodenum located to the right and left of Vater's ampulla, separated by a thin septum, and in the upper part of this the opening of the common duct was found. These diverticula were adherent to the head of the pancreas from which they could not be separated without an injury to their wall. The pancreas was of medium size and of regular structure. Width of the pylorus 5 cm. Width of the duodenum above the diverticula 12 cm. Width at the level of diverticula 9 cm., and below diverticula 8 cm.

In studying the literature on duodenal malformations, reports of about 250 cases of duodenal atresia could be collected. However, how seriously we can accept this low figure is questionable, because while atresia is by no means a frequent condition, Theremin, for instance, reports as many as nine

cases out of 150,000 births, which would indicate that more atresias occur than find their way into medical literature.

Statistics regarding duodenal diverticula also present a discrepancy inasmuch as many pathologists encounter it only rarely, while men like Grant and Baldwin report a surprisingly large number of cases. These two above-mentioned men conducted a specific search for diverticula in all their autopsies and Grant states his findings to be as high as 16.2 per cent. and Baldwin's were 13.3 per cent.

Returning to duodenal atresia, its origin has been attributed to many different causes and the opinions of those who have made research into it are widely diversified.

The very earliest explanations of atresia have been based on the belief that the intestines develop from a segmented tube and that there, where these segments failed to unite, atresias occurred. But now embryological studies have proven definitely that the intestines develop from one continuous tubal organ.

Wyss and MacDonald theorize that developmental error or primary aplasia of the vessels causes atresias. But this statement is far from being convincing and it is, to say the least, just as possible that obsolescence of the vessels is the consequence and not the cause of faulty intestinal development.

Other alleged causes of atresia include: Pressure of enlarged liver or pancreas (Christeller, Serr), cysts of the fossa ileocecalis (Schott), malformation of the mesocolon (Hess), hypertrophy of the intestinal folds (Hammer, Schnitzlein), lack of bile flow (Forrer), hæmorrhage, tumors, thrombosis, etc. All these statements are scarcely substantiated and the changes observed are more likely to be merely coincidental than causative factors. Steinthal, Kirschner and Thorel all believe intrauterine enteritis to be the cause of intestinal occlusion. Fiedler has claimed that fœtal peritonitis is the cause of atresia, yet in most cases no signs of adhesions, bands or scars could be seen. In our own case, although there were adhesions present, no relationship could be demonstrated between the bands and the dehiscence of the small intestines.

In a few cases of atresia cocci were found in the tissues (Markwald). In others, round-cell infiltration and signs of hæmorrhages were present which might point toward an infection as the cause. But it seems highly improbable to accept infection as the responsible factor of congenital atresia because the inflammatory changes are too insignificant. It is much more probable that they were secondary. Syphilitic infection can be dismissed also from our consideration as the children are born at term and are well-developed and show no other signs of lues.

Chiari, Brown and Karpa make an intrauterine intussusception responsible, but this has been refuted by Kuliga, firstly, because intussusception was found only in a few cases and therefore does not warrant its application as a general rule, and secondly, because the type of atresia found in those few cases of intussusception differed from the usual picture of the condition.

Kuliga after examining critically all the reports on atresias published up to 1903, and after a careful study of his own cases is at a loss to give a conclusive explanation but is inclined to believe in a developmental deviation from the normal.

Kuliga's suggestion is justified by the fact that the duodenum and those other parts of the small intestine where occlusions occur are the site of very complicated developmental processes. The duodenum, besides that it takes certain torsions to assume its formation and location, gives off certain buds from which develop the liver and pancreas, analagous to the condition existing in the œsophagus, from which, by means of budding, the lungs develop. Occlusions have occurred on this part of the œsophagus also. Still another site of the small intestine where we sometimes meet with occlusion is the place where the ductus omphalomesentericus enters and is another spot for complicated developmental conditions.

Kuttner, Gartner, Schottelus, Schlegel, Minich and Goode believe that the complicated mechanism of the torsion of the duodenum alone is the cause of congenital atresias.

Tandler has proven by histological examination of young embryos that proliferation of the epithelium is a physiological condition which develops and obstructs the duodenum when the embryo is from six to eight millimetres long. The proliferation reaches its height when the embryo attains sixteen millimetres and, according to Tandler, atresia occurs if this occlusion does not dissolve as it physiologically should, and remains permanent.

But Kuliga opposes Tandler's contention with two arguments. First he says, that according to the present pathological knowledge, there is never any fusion between epithelium-covered surfaces, unless the integrity of the epithelium has suffered some damage due to infection or irritation. This point does not hold. Although it is true that epithelium-covered surfaces do not fuse unless damaged, this does not apply to the embryonal epithelium which has quite different properties from that of the adult, as is seen in the fusion of the epithelium of the hepatic buds, which arise from the common duct and form the liver or the fusion of the mesothelial buds in forming the kidneys and adrenal cortex.

Kuliga's second and apparently quite logical argument against Tandler's theory is, that in some of the cases reported, meconium was found in the intestines distal to the atresia. This would indicate that occlusion occurs in older embryos, and therefore the atresia cannot be due to the proliferation which is present long before meconium develops. There is, however, some circumstantial evidence in favor of what Tandler has named "physiological proliferation," since similar processes were found also in the course of the development of the œsophagus and rectum by Kreuter, and in one case of congenital atresia of the duodenum there were also similar conditions prevalent in the œsophagus and rectum. (Meusburger.)

The review of the various opinions concerning the cause and pathogenesis of atresia seems to indicate that this condition cannot be explained on the

basis of a single assumption. In the majority of the cases, however, the condition is brought about by developmental errors, among which disturbance of the physiological proliferation of the epithelium, according to Tandler, is the most important.

As to the pathogenesis of diverticula, there is just as little concensus of opinion. We shall confine ourselves to the discussion of those diverticula which occur in the upper part of the duodenum and which can be classed as congenital on the basis of the following arguments: (1) Such diverticula have been observed in new-borns and in children. (2) Even if they are met with in adults, there is usually no evidence of pathological changes which could be made responsible for them.

In the case reported the double diverticulum was certainly not of the so-called tractional variety, and it must be considered as a pulsion diverticulum, similarly to the congenital diverticula mentioned above.

Pulsion diverticula are explained on the basis of local weakness of the intestinal wall and increased intraintestinal pressure. Examination of the diverticulum wall in the case reported showed that the wall was extremely thin and consisted mainly of the mucous membrane with no grossly visible musculature.

Increased intraintestinal pressure can be demonstrated only indirectly. It seems that the excessive distention of the duodenum above the diverticula warrants the assumption of some obstacle in the emptying of this part of the intestine with consecutive increase of pressure therein. There is, however, no actual obstacle present, occluding or narrowing the intestinal canal, nor is there any anatomical evidence of the previous existence of a kink. Thus the question is justified whether such an obstacle did not exist at an early time of the embryonal life, and while this obstacle was dissolved later on, its effect upon the duodenal wall still persists. We are referring here to the occlusion of the duodenum by epithelial proliferation as discussed above.

It is, of course, a hypothesis only, which cannot be substantiated, but this hypothesis is based on fairly sound analogies with other developmental errors of the duodenum. Further investigations of the duodenum in congenital diverticula would be required in order to decide whether atresias of the duodenum on the one hand and diverticula or diffused dilations of the duodenum on the other hand are not dependent on the same cause.

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# TUMORS WHICH MAY EXPAND THE CURVATURE OF THE DUODENUM, PARTICULARLY TUMORS AND INFECTIONS OF THE RETROPERITONEAL LYMPH NODES

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THE diagnosis of tumors of the upper abdomen may be difficult not only from the standpoint of their place of origin but no less from that of their pathological nature. It is the purpose of this paper to call attention to certain of these lesions which, as shown by the X-ray, serve to *expand the normal duodenal curvature,* and to point out the bearing of the deformity on proper treatment.

The writer's interest in the subject of the tumors which produce this characteristic deformation was initiated by his experience with the following case:

CASE I.—*P.B.B.H., Surg. No. 30157. Male, aged fifty-four. Large retroperitoneal erythrocytoma causing abdominal pain, weakness, loss of weight, diarrhœa, vomiting, and late and incomplete jaundice. Upward displacement of the stomach and a wide sweep of the duodenal loop shown by the X-ray. Anterior gastro-enterostomy and entero-enterostomy, followed by deep radiotherapy. Relief of vomiting and jaundice. Disappearance of mass. Uncontrolled diarrhœa. Inanition, death, autopsy.*

D. J. H., an Irish-American salesman, was admitted November 23, 1927, complaining of abdominal pain, diarrhœa and loss of weight. His bowels had been irregular for three years and he had had hemorrhoids. During the year preceding admission he had lost thirty pounds in weight but worked steadily and considered himself well.

Eight weeks before entry he had an attack of diarrhœa accompanied by lower abdominal cramps which persisted irregularly for three weeks. No blood or mucus was noted in the loose stools. Marked constipation followed the diarrhœa and he became conscious of distress in the left epigastric region immediately after each meal. For the two weeks preceding admission he repeatedly vomited large amounts of old and recently eaten food, charged blood and mucus. He finally was unable to retain even liquids, and weakness took him to bed.

Two days before admission he noticed that his relaxed skin was becoming yellow, and for the first time he felt a lump in his abdomen. Just after arrival in the ward he vomited a litre of chocolate-colored, coffee-ground material.

*Examination.*—This showed marked emaciation with a soft, lax, moderately jaundiced skin and yellow scleræ. Peristaltic waves, apparently gastric, could be seen passing repeatedly from left to right across the upper abdomen. There was a moderately tender, nodular, firm, elastic mass, the size of a large fist, in the upper abdomen, slightly to the right of the mid-line. There was a difference of opinion among several observers as to whether this mass was at all movable, but to the writer it seemed to be slightly so.

The mass was not connected with the liver, which could be palpated separately. A laterally displaced, distended gall-bladder could be felt beneath the rounded edge of the liver. There was no evidence of free peritoneal fluid.

From the stomach, 300 c.c. of fluid, containing old blood, was aspirated. It contained 20 per cent. sediment, free acid 46, and total acid 82. The benzidine test was strongly

positive, and the microscopic examination showed many red blood cells and Opler-Boas bacilli. The stools were clay-colored and chemical tests were negative for bile. Bile was present in the urine, which was otherwise normal. The van den Bergh reaction was direct, prompt and approximately four times the normal (4.05 units), indicating obstructive jaundice. Hæmoglobin, 75 per cent. (T); red blood cells 4,200,000. Bleeding time, ten minutes; clotting time, two minutes.

Barium fluoroscopic studies showed a dilated and atonic stomach. The antrum was narrow and displaced upward, while the greater curvature showed irregularities suggest-
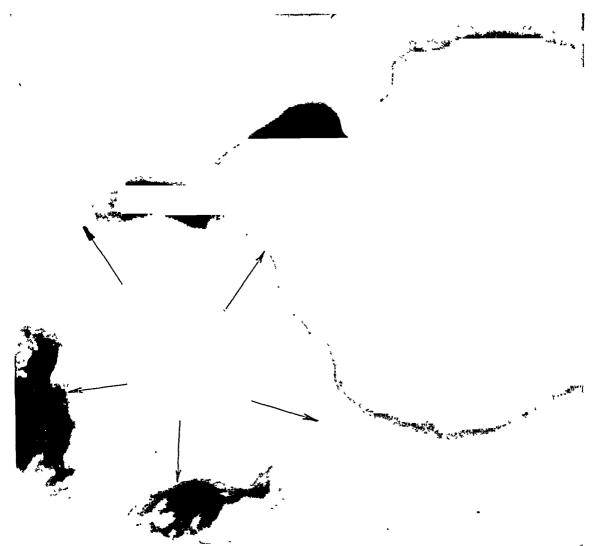


FIG. 1.—Case I. Duodenal loop widely expanded by a large retroperitoneal erythrocytoma involving the lymph nodes in the region of the head of the pancreas.

ing extrinsic pressure rather than intrinsic deformity. There was a six-hour residue estimated at 20 per cent. The duodenal cap could not be definitely outlined, but *the duodenal loop was expanded into a large circle surrounding the palpable mass in the epigastrium.* (Fig. 1.)

*Operation.*—The abdomen was explored under novocaine anæsthesia on December 3, 1927, and a large, firmly anchored, retroperitoneal tumor was found in the region of the head and body of the pancreas. The pyloric antrum, which was evidently adherent to the tumor, was displaced superiorly and anteriorly; the gastrocolic omentum and the transverse colon were pushed forward; and the duodenum was expanded into a widely-curved ribbon encircling the periphery of the tumor. The entire mass was approximately 12 cm in diameter, nodular, firm, elastic and rubbery.

There was no free fluid in the peritoneal cavity and the liver was distinct from the mass and free from metastases. There was a tensely dilated, thin-walled gall-bladder, which together with the right lobe of the liver was rotated by the mass to the right.

Inferiorly the tumor appeared to fill the root of the transverse mesocolon and to extend well to the left of the mid-line. Anteriorly it was adherent to the gastrocolic and gastrohepatic omentum, and, in this situation, several enlarged and freely movable lymph nodes were felt. One of these was excised and appeared both grossly and by frozen section to be hyperplastic but free from tumor. From the extremely vascular tumor mass itself, a small piece of tissue was, with difficulty, taken for histological verification.

An anterior gastrojejunostomy with an entero-enterostomy below the level of the transverse colon was made. In the course of this procedure an opportunity was given to observe the lumen of the pyloric antrum, where the mass was adherent, and it was found that the lesion was beginning to infiltrate the gastric mucosa.

Due to the patient's poor condition, any further prolongation of the operation, such as would have been necessitated by an effort to relieve the obvious obstruction to the common duct by a cholecystenterostomy, seemed unwise. Furthermore, the gall-bladder was displaced far from the stomach and the duodenum was partially obstructed so that the procedure would have been of doubtful value.

*Post-operative Course.*—The patient was put on a liquid diet, and with the exception of a single attack of vomiting on the sixth day, he appeared to be doing well. On the eighth day the stomach was aspirated and only 30 c.c. of mucoid, bile-containing material could be obtained. The jaundice decreased in intensity and by the twelfth day, when the stools had begun to regain color, the van den Bergh test showed only 0.6 units contrasted with 4.05 units before operation. At about this time the patients former tendency to diarrhœa recurred and in spite of scrupulous cleanliness a small decubitus appeared over the sacrum.

On the sixteenth post-operative day a fluoroscopic study with barium showed an irregular, apparently fixed pyloric antrum which was narrowed and without peristalsis. Most of the barium emptied through the anterior gastro-enterostomy. The stoma was movable and was not tender. There was a six-hour gastric residue distal to the stoma estimated at 10 per cent.

A microscopical study of the piece of tissue removed at operation meanwhile showed that the tumor was an unusual one (an erythrocytoma), and, beginning on the nineteenth post-operative day, the patient, under Doctor Sosman's direction, was given four deep X-ray treatments at two-day intervals.* The first treatment caused no reaction but the second resulted in a rise in temperature, nausea and weakness.

In spite of the fact that the radiation had a pronounced effect on the tumor mass, so that by the thirty-fifth day it was no longer palpable, the patient became increasingly more emaciated and cachectic, the diarrhœa continued, the decubitus enlarged and he died on the thirty-seventh post-operative day (January 9, 1928).

*Autopsy.*—Anatomical diagnoses: Retroperitoneal erythrocytoma (absorbed by radiation), acute fibrinous pericarditis (aseptic), chronic bronchitis, aplastic bone marrow, peritoneal adhesions, emaciation.

The large tumor mass present at the operation five weeks previously had entirely disappeared. The gastro-enterostomy and entero-enterostomy were intact (but there was no functional need for them, as there was no intestinal obstruction).

The fatty tissue around the head of the pancreas and in the transverse mesocolon showed considerable induration, and in it were several button-like nodules which appeared to be lymph nodes, so firmly imbedded that they were dissected out with difficulty. The mesenteric nodes were similar in appearance, not exceeding 1.5 cm. in greatest dimension.

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* Alternating posterior and anterior treatments, directed through the epigastric and upper lumbar regions, were given. All dosages: 30 min., 40 cm., 4 m.amp., 182 kv., ½ mm. copper and 1 mm. aluminum screen, 50 per cent. S.U.D., 20 x 20 cm. portal.

Nothing grossly resembling tumor tissue was anywhere to be seen. The spleen was small and fibrous. The peripheral lymph nodes appeared to be normal.

Microscopical examination by Dr. Henry Pinkerton of the nodules mentioned above showed areas of cellular tissue containing nucleated red cells and more primitive hemoplastic cells. Lymph follicles were absent but there were large phagocytic cells, often laden with hemosiderin.

Comparison with the tissue taken at operation showed a disappearance of the obviously neoplastic hemapoietic tissue then present. It was now largely replaced by fibrous stroma.

Aroused by the peculiar deformation disclosed by the X-ray in the primary examination of the case reported above and with the idea that it might be of significance in the differential diagnosis of lesions in this region, the writer sought in the hospital records for other similarly placed retroperitoneal tumors, with the purpose in mind of making a comparative study of the gastro-intestinal X-ray films in their relation to other symptoms and signs which were soon found to require consideration.

Out of several cases that seemed promising from the clinical histories, four were found in which the typical deformity was either unmistakable on the X-ray films or was clearly described by the röntgenologist in his report. In two of these cases the pathological process was lymphosarcoma, in one metastatic carcinoma in lymph nodes, and in another chronic pancreatitis with cyst formation.

During the course of this inquiry and while Case I was still fresh in mind, a patient was admitted to the ward who proved to have a moderately expanded duodenal loop, but from another and an unusual cause. The history of this case follows:

CASE II.—*P.B.B.H., Surg. No. 30548. Female, aged forty-four,. Carcinoma (unverified) of head of pancreas with moderate expansion of the duodenal loop, as seen at fluoroscopy, and jaundice. Exploratory laparotomy. Cholecystogastrostomy with relief of jaundice. Improvement in condition and gain in weight.*

S. C. F., a school-teacher, was admitted to the medical service on January 16, 1928, complaining of deepening jaundice, weakness and loss of weight. Her general health had been good until seven months before admission, when she began to have distress in the epigastrium and raising of gas shortly after eating. Bicarbonate of soda gave only partial relief. On a single occasion she vomited a small amount of greenish material. There was no hematemesis or melena.

The indigestion continued and two months before admission she had "bronchitis" with sharp pain in the anterior portion of the right chest, night sweats, thin yellow sputum and questionable jaundice. This illness was succeeded two weeks later by a persistent dull pain in the mid-epigastrium and right upper quadrant of the abdomen. She became progressively weaker, markedly emaciated and more jaundiced; and had itching, clay-colored stools and dark urine.

*Examination.*—This showed a small woman whose skin was relaxed, wrinkled, markedly jaundiced, and excoriated from scratching. The enlarged liver and smooth, moderately tender gall-bladder could be felt in the right upper abdomen. A separate, ill-defined, firm, fixed mass, which did not descend on inspiration, was felt in the right epigastric region.

The temperature was normal; the pulse was regular, rate 70–88; respirations were 20; blood-pressure 118–80; hæmoglobin 80 per cent. (T), red blood cells 4,700,000, white blood cells 7,200, differential leucocyte count normal, red cells and platelets normal.

The urine contained a large amount of bile. A stool on admission was light brown, benzidine ++++; five days later a sample was clay-colored. The bile-index was 50 (normal, 3–10); van den Bergh, direct, prompt reaction, 8.8 units on admission (normal, 0.5–1.5); unchanged one week later. Bleeding time 8 minutes, 35 seconds. Blood Wassermann reaction + + on two determinations. The gastric analysis showed no free acid in any of the specimens and the total acid curve was low.

The barium fluoroscopic studies revealed a low, hypotonic stomach, smooth in outline, with good peristalsis and no six-hour residue. The duodenal cap was medium in size, smooth in outline, not fixed or tender, but it was displaced laterally, and *the whole duodenum formed a circle around an irregular, nodular mass.* The röntgenologist's impression was of a tumor in the head of the pancreas.

*Operation.*—Exploration and a cholecystogastrostomy were carried out by Doctor Cheever on January 26, 1928. The gall-bladder was distended and thin-walled, one and one-half times the normal size, and the liver-edge was rounded and moderately thickened.

A large, firm mass was palpable behind the pyloric antrum in the region of the pancreas, extending well over toward the tail of the pancreas and involving the head of the organ so that it was two to two and one-half times its normal bulk. No distinct nodules could be felt, however, and no enlarged regional lymph nodes were palpated. The tumor was considered to be a carcinoma of the head of the pancreas, but no tissue was removed for microscopic verification.

A large amount of very dark, concentrated bile, containing much mucus, was evacuated from the gall-bladder, but no calculi were found. The common duct was not opened or exposed. A cholecystogastrostomy was performed just proximal to the pylorus.

*Post-operative Course.*—The convalescence was uneventful and the jaundice gradually disappeared. Bile was noted in the stools on the eleventh day, and the patient was discharged improved on February 13, 1928.

A letter from her physician on September 4, 1928, reported that the patient had rapidly regained her appetite and strength, and had increased thirty pounds in weight. She had had no recurrence of her jaundice, but, once in March and twice in July, had had gastric upsets with nausea and vomiting, but no pain. The only pre-operative symptom which had persisted was infrequent night sweats.

The diagnosis of carcinoma of the head of the pancreas in the case reported above is questionable. If the patient continues to improve, a chronic pancreatitis, possibly tuberculous, is the alternative.

The radiographs showing the enormously expanded duodenal loops in Case I (Fig. 1) and in Case V (Fig. 2), to be reported later in the paper, are most striking, and the röntgenologist's descriptions of the fluoroscopic findings in four other cases are equally so. One of the patients, whose case record follows, was seen as early as 1918, while the others were more recently in the hospital:

CASE III.—*P.B.B.H., Surg. No. 7954. Male, aged seventy-two. Pain in the abdomen and back. Palpable tumors, expansion of the duodenal curvature seen on fluoroscopic examination, no jaundice. Exploration, probable retroperitoneal lympho-sarcoma. No X-ray therapy. Progressive failure. Death at home. No autopsy.*

F. C. J., a native-born printer, was admitted on January 4, 1918, complaining of dull pain in the right side of the abdomen and back.

Beginning five months before admission he gradually weakened, lost his appetite and lost weight. A constant ache, occasionally increasing to sharp pain, began in the right upper abdomen and occasionally radiated to the right lower back. During the two months before admission most of his stools were stated by the patient to be tarry, while

in the out-patient department one month previous to entry, following an exacerbation of pain, a small but definite amount of bile was found in the urine.

*Examination.*—The patient was a well developed, moderately emaciated old man with no jaundice and no enlargement of the lymph nodes. Blood-pressure 166–70. A lobulated, hard mass (size not stated in the history) was felt half way between the umbilicus and the ensiform process, a little to the right of the mid-line, and a rather indefinite tender mass could be felt further out to the right, curving up toward the edge of the ribs. This was not interpreted as the liver or the gall-bladder, and these organs could not be palpated.

The urine was normal. Hæmaglobin 75 per cent. (T), white blood cells 12,000. The stomach contents were rancid and contained old food particles. No free acid was found in the fasting, first, second or third specimens, and the total acid ranged from 0 to 30.

Bismuth examination showed that the stomach was normal but that *the duodenum was stretched out around the palpable abdominal mass.*

*Operation.*—Exploration by Doctor Homans on January 10, 1918, under novocaine anæsthesia, showed a hard, very slightly lobulated, retroperitoneal mass in the region of the head of the pancreas. It was several inches thick in an antero-posterior direction and the duodenum was expanded by it, making a long curve around the tumor. The mass became gradually smaller toward the tail of the pancreas. On the surface could be felt one or two fixed, hard lymph glands. One node was removed (this was later found normal on microscopic examination), but no specimen was taken from the growth since the important vessels supplying the transverse colon ran through it.

The gall-bladder was large and rather tense, but could be emptied on pressure. No metastases were seen in the liver and the liver was not enlarged. The stomach, the transverse colon and the other structures in the field appeared normal.

*Post-operative Course.*—The convalescence was uncomplicated but the temperature became irregular and his marked weakness persisted, so that it was necessary to send him home in an ambulance (January 29, 1918).

A letter from his wife stated that he died three weeks after discharge from the hospital. No post-mortem examination was made.

Though the impression gained at operation in the above case was of carcinoma of the head of the pancreas, it would be preferable, on the basis of the clinical history, physical and X-ray findings, to make a diagnosis of a malignant retroperitoneal tumor of some other origin. It will be noted that there was no jaundice (except a transient attack of slight degree one month before admission), that the abdominal mass was palpable, and that the duodenum was "stretched out" around the mass. Such extensive carcinoma in the head of the pancreas itself would almost surely cause marked jaundice. This was probably a case of retroperitoneal lymphosarcoma or metastatic carcinoma, though, unfortunately, no tissue for verification was obtained at the operation.

An interesting instance of expansion of the duodenal circle by a chronic inflammatory process, with necrosis and cyst formation, is found to be recorded in the following history of a patient admitted five years later:

CASE IV.—*P.B.B.H., Surg. No. 20137. Male, aged forty-one. History of pulmonary tuberculosis. Abdominal pain, melena, anorrhexia. No jaundice. Palpable abdominal mass which projected the stomach upward, expanded the duodenal circle, and displaced the transverse colon downward, as seen at fluoroscopy. Exploration showed*

*chronic pancreatitis (? tuberculous) with necrosis and cyst formation. Draining. Recurrence of old pulmonary symptoms suggesting phthisis.*

M. W. was admitted to the surgical service on November 16, 1923, complaining of abdominal pain. Eight years previously he had been in bed for three months with pulmonary tuberculosis and pleurisy with effusion. This illness was accompanied by night sweats and a chronic cough with which he raised large amounts of bloodless sputum. He lost weight, became exhausted, and was sent out West for a year's vacation. He then became a cattle-rancher, improved and had no more pulmonary symptoms.

Three months previous to admission he began to have mild attacks of indigestion about once a week, none of them sufficiently severe to keep him from work, and, as a rule, readily relieved by soda.

Beginning two months before entry he occasionally noticed liquid, red blood in his stools and two weeks before admission he had a dizzy spell, accompanied by a cold sweat and sharp, cramp-like pains over the whole upper abdomen. At this time he vomited several times but there was no blood in the vomitus. After this attack he continued to have generalized pain in the upper abdomen, occasionally quite sharp, and his appetite became poor.

*Examination.*—The patient was normally developed and showed little evidence of loss of weight. The skin was not jaundiced and there was no enlargement of the peripheral lymph nodes. Blood-pressure 130–80.

The abdominal panniculus was thick and the abdomen was prominent, especially in the epigastrium, where a large, firm, smooth, insensitive mass was felt completely to fill this region. It moved slightly with respiration, was fixed posteriorly and did not seem to be adherent to the liver or the anterior abdominal wall. The liver itself could be felt about two centimetres below the costal margin, but the gall-bladder was not palpable. The lower abdomen was normal and no free peritoneal fluid could be detected.

The temperature, pulse, and respirations were normal. The urine was negative; benzidine test on stools, —, —, — (three determinations); bile +; no parasites were seen. The blood Wassermann was negative; hæmoglobin 85 per cent. (T); white blood cells 7,700. The differential blood count, blood smear examination and gastric analysis were not carried out.

Barium fluoroscopic studies showed a large filling defect on the greater curvature side of the pyloric antrum. *The duodenum was flattened and deformed and swung widely around the palpable mass.* At six hours there was no gastric residue and the head of the barium column was in the transverse colon. The latter was narrowed and was pressed down by the mass felt in the abdomen. The röntgenologist gained the impression of a mass arising from the pancreas.

*Operation.*—Exploration by Doctor Cheever on November 19, 1923, disclosed a small amount of thin, serous, free peritoneal fluid, and an enlarged, smooth liver. There was a large mass behind the stomach and transverse colon, both of which were displaced forward by it. The gall-bladder was normal and flaccid but was adherent to the gastro-hepatic omentum against the mass.

On opening the pancreatic capsule through the gastrocolic omentum, a tablespoonful of necrotic, bloody, nearly black, cystic fluid escaped and was immediately cultured. Several other small pockets containing similar fluid were broken into and some strips of partially degenerated tissue were saved for histological examination. No enlarged lymph nodes and no areas suggesting tuberculous caseation were seen. The pancreas was drained.

*Post-operative Course.*—For several days there was a moderate discharge of dark, irritating fluid from the wound. The temperature slowly subsided and the patient was discharged on January 14, 1924, a little less than two months after operation, with a completely healed wound. The mass had disappeared and there was no evidence of pancreatic insufficiency.

The cultures taken from the pancreas at operation produced no growth. The microscopic sections showed necrotic, chronically-inflamed pancreatic tissue with no definite evidence of tuberculosis.

A letter from the patient's wife one year after discharge told of a recurrence of the pulmonary symptoms. He had had, however, no further complaints referable to the abdomen.

The chronic pancreatic inflammation in the above case resulted in necrosis and the formation of multiple areas of liquefaction. It is probable that this process, if allowed to progress, would have resolved itself into a single large cyst in the head of the pancreas, resulting in still further expansion of the duodenal curvature.

Among all of the films showing expansion of the duodenal arc, that from the following case (Fig. 2) is the most striking:

CASE V.—*P.B.B.H., Surg. No. 22834. Male, aged fifty-eight. Displacement of the stomach and expansion of the duodenal loop by a large retroperitoneal tumor, probably lymphosarcoma. Exploratory laparotomy. Deep X-ray therapy. Death at home. No autopsy.*

J. H. R., a Canadian truckman, was admitted to the surgical service on December 22, 1924, complaining of swelling of the abdomen and of the right leg. For thirty-two years he had had "chronic dyspepsia" and occasionally he had been awakened during the night by epigastric pain which was relieved by massage of the abdomen and a drink of ginger tea. No relation of the pain to his meals could be elicited. Soda and an ulcer diet gave no relief. He had never been jaundiced.

His present illness began three months before admission with painless swelling of the right ankle and leg. For six weeks he had noticed fulness of the abdomen and œdema of the scrotum. More recently he had become dyspnœic. He gave no history of loss in weight or strength. His habitual slight constipation had become more marked in the later three or four weeks and he had had occasional mild colicky pains through the lower abdomen.

*Examination.*—This showed a short, stocky individual with soft skin and distinct cachexia, but no jaundice. In the epigastrium between the xiphoid process and the umbilicus there was a mass the size of a man's fist. This was firm, roughly nodular, slightly tender, fixed, and did not move with respiration. The liver was not felt, possibly due to the moderate distention of the abdomen with fluid. Rectal examination was negative.

The temperature was 98°, the pulse 64, respirations 20. Hæmoglobin 95 per cent. (T), red blood cells 4,600,000, white blood cells 8,100. The differential leucocyte count was normal. The urine showed a few white cells; specific gravity 1015; no bile was present. The stools were normal, contained bile and showed no gross, microscopic or chemically detectable blood on repeated examinations. No blood and no free hydrochloride was found in any of the specimens obtained by tube from the stomach, and there was a very low total acid curve.

The colon was normal by barium enema, but a gastro-intestinal fluoroscopic study showed, with the patient in the prone position, that the greater curvature of the stomach was arched upward, suggesting pressure by an intra-abdominal mass about in the midline. The duodenal cap was normal but *the duodenal curvature made a wide sweep around the periphery of the mass.* (Fig. 2.) There was no gastric stasis and peristalsis was normal.

*Operation.*—Exploration by Doctor Cheever on January 5, 1925, disclosed a small amount of free, serous, straw-colored fluid in the abdomen. The liver and gall-bladder appeared normal. The portal vessels on the surface of the viscera and through the

mesenteries were dilated and dark. An irregular, diffuse tumor presented behind the stomach and transverse colon. It arose behind and below the pancreas, which was itself normal, and extended to the right and left, obscuring the hilus of the left kidney. There were many soft, enlarged lymph nodes in the mesentery of the proximal jejunum and one of these showed after removal, both by immediate frozen section and by a later more careful study, lymphoid hyperplasia, but no malignancy.
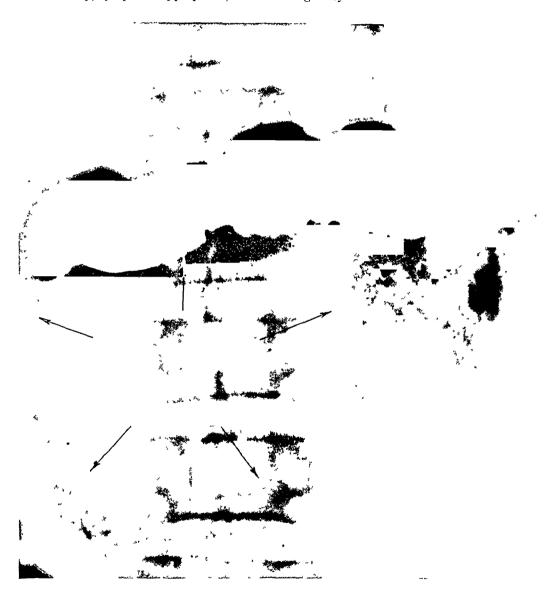


Fig 2 —Case V. Marked expansion of the duodenal arc by a mass of enlarged retroperitoneal lymph nodes

After healing of the undrained wound the patient was given two deep X-ray treatments.† He was discharged from the hospital on January 22, 1925, and returned for X-ray therapy on February 11, March 4, March 25, and April 3.‡ The abdomen became well tanned and the mass became less distinct to palpation. Approximately three and one-half

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† (1) Epigastric area, anteriorly, 20 min., 12 in., 6 m.amp., 9 in.-spark-gap, ¼ mm. copper and 1 layer sole-leather, screen; (2) the same dose the following day, posteriorly.

‡ The same dosage as before was used and alternating anterior and posterior treatments were given.

months after his operation the patient became too ill to come to the hospital, so that no further radiotherapy was given.

A letter from a relative told of a gradual failure in health, with excessive pain in the back and legs, epistaxis, sweats, weakness, and loss of weight, which led up to his death on August 14, 1925. No autopsy was performed.

The Röntgen treatment in the last case reduced the size of the abdominal mass, but had no appreciable effect in prolonging life. It is quite possible that exploration, which, in the light of our present knowledge of the tumors which cause an expansion of the duodenal loop, is unnecessary in such cases, considerably weakens the patients, and contributes to their early exhaustion before the favorable effects of the X-ray therapy can be manifested.

In the final case encountered, in which a marked expansion of the duodenal arc was described, the deformity was due to a mass of metastatic carcinomatous lymph nodes in the region of the head of the pancreas. The record follows:

CASE VI.—*P.B.B.H., Med. No. 28695. Male, aged thirty-three. Embryoma of right testicle recurrent in retroperitoneal lymph nodes. The large mass caused elevation of the stomach and wide expansion of the duodenal loop as seen at fluoroscopy. No jaundice. Deep X-ray therapy with relief of abdominal pain and disappearance of mass. Recurrence of pain in abdomen and right leg one year later. Emaciation; spontaneous fracture of right thigh. Death; no autopsy.*

S. G. B., a salesman, was admitted to the medical service on October 5, 1926, complaining of lumbar backache. A right orchidectomy for "embryonal carcinoma" had been performed in a nearby city on September 28, 1925, following which he had there been given several X-ray treatments which were continued up to the time of admission.§

During the six weeks preceding his entry to the hospital he had suffered, particularly at night, from sharp pain to the right of the umbilicus, radiating through to the lumbar region and into the left testicle. Eructations of gas from the stomach had been troublesome but there had been no vomiting. He had eaten little food and had lost moderately in weight.

*Examination.*—This showed a heavy, robust individual. The right testicle had been removed and there was no local recurrence of the tumor. Between the right costal margin and the umbilicus there was felt a slightly elongated, smooth, hard, moderately tender, fixed mass about the size of a large gall-bladder. It was not considered to be this organ, however, since it did not descend with inspiration and since the liver could not be palpated. There were no signs of free fluid in the peritoneal cavity.

Cholecystograms disclosed a normal gall-bladder. There was no röntgenologic evidence of metastatic tumor in the chest or spine. The barium fluoroscopic studies showed the stomach to be high and hypertonic with sluggish peristalsis, and no six-hour residue. It was displaced upward and the antral portion of the greater curvature was concave, due to pressure by an extrinsic mass. *The duodenum emptied downward and swung widely around the same mass.* There was no duodenal or pyloric obstruction.

The temperature was normal; blood Wassermann ++, +, ++ (three determinations). The urine was normal and contained no bile; stool normal; icterus index 5, 5 (normal). Hæmoglobin 90 per cent. (T), red blood cells 5,000,000, white blood cells 6,900. The differential leucocyte count and blood smear were normal.

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§ Ten treatments between October 27, 1925, and August 25, 1926, directed in rotation, anteriorly and posteriorly, through the lower right abdomen, and right groin and scrotum. All dosages: 10 min., 12 in., 5 m.amp., approximately 150 kv., screening not noted on record.

The patient was discharged to the care of his local physician who supervised the giving of a series of antiluetic and deep X-ray treatments, the latter similar to those he had had before admission to the hospital. A note written one year after discharge, by Doctor Levine, under whose care the patient had been while in the hospital, stated that the abdominal mass had disappeared and that the patient then had no complaints. A recent letter from his physician related, however, that shortly after Doctor Levine's note was written the patient began to fail, became extremely emaciated and suffered extreme pain in the right leg and knee. In April, 1928, he fractured his right thigh while taking a bath, and was removed to a hospital where he died six months later. No autopsy was performed.

In order to gain a better idea as to the probability of expansion of the duodenal arc by carcinoma of the head of the pancreas, the autopsy records of the patients who had died of this disease in the hospital were briefly reviewed.

In most of these cases the tumors were quite small, but in three instances they were of moderate size, recorded as 16 x 9 x 7 cm., 6 x 6 cm., and 6 x 3 x 3 cm., respectively. In the first and third of these cases an attempt had been made to make a diagnosis by gastro-intestinal barium fluoroscopic studies and in both instances no abnormality of the duodenum was seen.

However, in the first case, which concerned a New England housewife, aged forty-one, the X-ray observation was made almost four months before death. During this time the tumor might well have enlarged considerably. In the third case, that of a negro, aged fifty, the tumor was hardly large enough to cause definite expansion of the loop. In the second instance, recorded of a prison-guard, aged sixty-five, the patient, by the time his tumor had grown large enough to possibly expand the duodenal loop, was far too sick to withstand barium studies.

All three of these autopsied patients had histories and physical signs quite typical for carcinoma in the head of the pancreas. In each the early onset of progressively deepening jaundice constituted a prominent feature, and equally consistent was the fact that in none of them was an abdominal mass definitely palpated.

*Discussion.*—In order to expand the duodenal curvature, a tumor, *e.g.*, a cyst of the head of the pancreas, must be fixed within the duodenal arc. Except by direct invasion of the pancreas with consequent fixation, a tumor of the transverse colon could not cause the deformity, for the mass of tumor would more naturally project forward in the direction of least resistance. An omental cyst, likewise, could not conceivably cause this expansion. Similarly, a mass in the region of the gall-bladder might cause a pressure defect in the duodenal cap, but would not expand the loop. Likewise, a hydronephritic kidney would be more likely to rotate the duodenum anteriorly or medially, though it is possible that a malignant tumor of the right kidney or upper ureter might so invade the pancreas or retroperitoneal lymph nodes as to cause expansion of the duodenal circle.

Enlargement of the curve of the duodenum can occur, then, only when some fixed and expanding lesion in the region of the head of the pancreas is

present. The pathological processes which may cause this deformation are consequently limited to retroperitoneal tumefactions in this situation, and of the following possible sources and varieties:

| *Tissue* | *Tumor* |
|---|---|
| Lymph vessels and glands..... | Chylous cysts; lymphangioma; lymphoblastoma (including lymphosarcoma and Hodgkin's disease); tuberculosis of lymph nodes; metastatic malignancy in lymph nodes. |
| Blood vessels and cells........ | Erythrocytoma; endothelioma; retroperitoneal hæmorrhage or "pancreatic apoplexy" with blood clot; aneurysm of pancreatico-duodenal or superior mesenteric artery. |
| Nerves .................... | Neuroblastoma. |
| Fibrous tissue .............. | Fibroma, lipoma, etc.; fibrosarcoma, etc. |
| Glandular tissue ............ | Pancreatic cysts (with or without infection, calculi or tumor as the cause); pancreatitis, chronic (including tuberculous pancreatitis); carcinoma of head of pancreas (acini or islands); carcinoma, lower segment common bile duct or ampulla of Vater; malignant right renal or ureteral, colonic or gastric tumors with direct invasion of the pancreas; benign and malignant tumors arising from cell rests (Wolffian body, etc.); echinococcus cysts of the pancreas (or surrounding tissues); tumors or infections invading the pancreas from the posterior parietes, spine, etc. |

It will be seen at once that most of these lesions that serve as possible causes of expansion of the duodenal loop are rare. The incidence among the cases reported, collected over a considerable period, may be taken, reasonably, as an indication of the more common lesions which cause the deformity. These group themselves readily into (1) lesions originating outside of the pancreas, and (2) those arising within the pancreas itself.

It is significant that to the first group belong the three cases which, of the six reported, caused the most marked expansion of the duodenal arc (Cases I, V and VI, Figs. 1 and 2). This expansion, in all three instances, was due to the enlargement of lymph nodes in the region of the head of the pancreas, in one case due to an erythrocytoma affecting the lymph nodes, in the second by a lymphosarcoma and in the third by carcinoma, metastatic in the lymph nodes from a malignant tumor of the testicle.

Of all the possible extrinsic causes of the deformity in question the lymph-node tumors and infections, including Hodgkin's disease and tuberculosis, are undoubtedly by far the most common.

Lesions originating in the pancreas itself apparently far less often produce significant degrees of the deformity. There is a good reason for this in that the most common lesion of the head of the pancreas, carcinoma, obstructs the common bile duct, dams back the external pancreatic secretion and causes death before the tumor reaches a size sufficient to expand the duodenal curva-

ture. Whereas retroperitoneal sarcoma or tuberculosis is likely to produce a large mass which, first, displaces the common bile duct but does not occlude it and consequently causes little or no jaundice, and which, second, in growing, expands the duodenal arc into a narrow ribbon around its periphery, carcinoma of the head of the pancreas usually produces a small mass, early, deepening, complete jaundice, and little or no expansion of the normal duodenal curvature.

Chronic pancreatitis, the second most common disease of this organ, appears occasionally to result in a sufficient enlargement of the head to expand the duodenal arc; (an example is to be found in Case IV). This it does by the inflammatory infiltration of the pancreatic tissues and by the formation of cystic collections of fluid. However, the cysts are not very common and they more often occur in the body of the organ than in the head, in which case they do not result in expansion of the duodenal arc.

For the same reason that carcinoma arising in the head of the pancreas does not often result in significant expansion of the loop, carcinoma of the lower segment of the common bile duct or of the papilla of Vater, would hardly be expected to cause the deformity. These tumors which are in such intimate relation to the duodenal wall are more likely to invade it, causing irregular deformities or constricting and partially obstructing it. Nevertheless, slight expansion may occur in conjunction with the deformities, as is shown by a case of carcinoma of the pancreas reported by Püschel [1] (Fig. 3, p. 498) in which there was partial obstruction of the duodenum by the tumor growth, apparently accompanied by some expansion of the loop; likewise, as shown by Assmann's note [2] (Fig. 569) of a case, presumably of carcinoma arising at the papilla, in which there was minimal expansion of the loop in addition to the more common irregularities which these tumors may cause in the duodenum.

The diagnosis by X-ray visualization of lesions arising within the head of the pancreas is, then, with the exception of large cysts in this situation, seldom accomplished, because of the small size of the tumors as compared with those of extrinsic origin of which the lymph-node tumefactions are the most numerous.

Expansion of the curve of the duodenum must be quite marked before it can be considered definitely pathologic by X-ray visualization. The normal variations in the curvature and length of the loop are considerable (David, [3, 4] Dorner, [5] Chaoul, [6] Case, [7] Herrnheiser, [8] Palmieri, [9] Béclère and Porcher [10]), and Buckstein's [11] studies appear to show that there is no constant relationship between habitus and the appearance of the curve.

Whereas a mass of diseased lymph nodes which extends into the region of the head of the pancreas, or a cyst in this situation, usually expands the duodenal circle, it should be recognized that a similar mass or cyst is just as frequently encountered which arises at the base of the transverse mesocolon or within the body of the pancreas, and which causes a pressure defect in the greater curvature of the stomach and in the transverse colon, but does not affect the duodenum. Occasionally a mass of enlarged lymph nodes is so placed as to rotate the entire duodenum and pyloric antrum upward and to

the left. Many variations of these extrinsic deformities of the stomach, duodenum, jejunum and colon may, of course, be encountered (Schlesinger,[12] Quimby,[13] Albu,[14] Zondek,[15] Christopher,[16] Gross, O.,[17] Piergrossi,[18] Buckstein,[19] Muzii [20]).

Previous to the operation, the author presumed that the patient in Case I had a carcinoma of the pancreas. Two facts were against this diagnosis, however: first, the late onset and the incomplete character of the jaundice; and second, the large size of the abdominal mass. Similarly, in Case III, the operator's impression, even at operation, was that of carcinoma of the head of the pancreas, though, as has been pointed out in connection with the history, the evidence (on the same basis as in Case I) is preponderantly in favor of lymphoblastoma.

In further support of this contention it has been shown by Minot,[21] in his study of a large series of cases of lymphoblastoma, that, though 25 per cent. of his patients had as their initial symptom one referable to the abdomen, jaundice if it appeared at all was a late manifestation. He notes, however, as an exceptional instance, the occurrence of jaundice as a primary symptom in one of his cases of abdominal Hodgkin's disease, and refers to Pepper's [22] clinical case. In addition, Rutecki,[23] Stahr and Synwoldt,[24] and Day [25] have described unusual cases of lymphosarcoma or Hodgkin's disease presenting obstructive jaundice as a primary or very early symptom, usually due to compression of the common bile duct by enlargement of adjacent lymph nodes, or, as in Day's example, to a mass which included and largely replaced the head of the pancreas. Likewise, the possibility of the occurrence of early jaundice as a result of the enlargement of tuberculous lymph nodes similarly situated has been suggested by Roepke.[26] Also, in cases of retroperitoneal tumor, early and extensive metastases to the liver might cause jaundice as an early symptom, but this must occur very rarely as I am unable to find a report of any specific instance in the literature.

This much may be said, as a rule, of jaundice in relation to these tumors which expand the duodenal curvature, that, in the case of tumors arising in the neighborhood of the head of the pancreas and in instances of slowly growing pancreatic cysts not accompanied by much inflammation, jaundice, if it occurs at all, appears late in the disease and the common duct obstruction is incomplete, whereas in the presence of carcinoma in the pancreas itself or carcinoma arising in the papilla of Vater or the lowest segment of the common bile duct, the jaundice appears early in the disease and progressively deepens due to complete common duct occlusion.

Metastatic carcinoma in the retroperitoneal lymph nodes may form a large mass in the region of the head of the pancreas. The history of a patient with metastases from a tumor of the testicle which caused partial stenosis of the duodenum is related by Jonas.[27] A similar tumor may, as in Case VI in this paper, result in marked expansion of the duodenal loop.

Without resort to special methods for duodenal X-ray visualization, any significant degree of expansion of the duodenal arc is readily demonstrable

during a routine gastro-intestinal fluoroscopic study, provided that the röntgenologist habitually insures that the duodenum is made to fill with barium and that he places the patient in the positions necessary completely to visualize it. The expansion is usually best seen with the patient in a right prone position while moderate pressure is exerted against the abdominal mass which causes the deformity. The radiologist must, naturally, be familiar both with the limits of normal variation of the loop and with the many deformities, other than the expansion with which we are concerned, which may occur.

The rapid and complete disappearance of the abdominal mass in Case I under deep X-ray therapy was astonishing. It is probable that radiotherapy alone, without the gastro-enterostomy, would have relieved the patient's duodenal obstruction, just as. it relieved his jaundice for which nothing was done at operation, and the unnecessary operation undoubtedly reduced his strength. In retrospect, based on our present knowledge of the lymph-node tumors which most frequently cause expansion of the duodenal curvature, the exploratory operations in Cases III and V as well as in Case I might better have been omitted and replaced by primary X-ray therapy. Of course, even in these cases of expansion of the duodenal loop, when there is reason to suspect an active inflammatory process (tuberculous or otherwise) in the pancreas or adjacent lymph nodes, where a pancreatic cyst, which might be drained, is presupposed, or when there is marked jaundice which does not quickly respond to deep X-ray therapy, operation is indicated. A degree of duodenal obstruction, complete enough to require immediate gastro-enterostomy without a trial of the effect of radiotherapy on the obstructing mass, would be extremely unusual.[¶]

In Case I the erythrocytoma was quickly absorbed by the deep röntgen-therapy and the histologic comparison between the tissues removed at operation and at autopsy showed a marked reduction in the number of the tumor-forming blood elements and an apparent actual increase in the amount of fibrous-tissue stroma. The change was similar to that seen in a large retro-peritoneal lymphoblastoma, which had been intensely irradiated between the time of exploration and death, described by Mathé.[28]

*Literature.*—Among his many contributions to the early studies of gastro-intestinal radiology, Holzknecht[31] in 1910 suggested the possibility of observing changes in the form of the duodenum after the oral administration of bismuth. In the same year, Crane[32] proposed an attempt to diagnose tumors in the head of the pancreas through observation of the duodenum during bismuth X-ray studies.

Shortly afterward Skinner[33] described a technic by which he directly filled the duodenum with a bismuth mixture through a duodenal tube devised

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[¶] The X-ray studies and treatments in all of the more recent cases reported in this paper have been carried out under Doctor Sosman's direction, and the treatments have conformed in general to the principles outlined by Desjardins[29] and Evans and Leucutia.[30]

by Gross,[34] in order more clearly to visualize the organ. He suggested that his method would be useful for outlining the head of the pancreas.

There followed in 1913, 1914 and 1915, several papers by David [3, 4, 35] in which he set forth a similar technic by which he was able to visualize instances of duodenal obstruction, while Chaoul [6] in 1916 demonstrated, by reproducing many illustrations of his X-rays showing variations in the normal and pathologic duodenum, the efficacy of his simple technic for fluoroscopic observation. In carrying out his method he turned the patient in a right prone position and temporarily obstructed the duodenum by abdominal compression of its third portion against the spine, while the duodenal loop filled, consequently, with bismuth from the stomach. This is essentially the technic routinely used in our own X-ray department to detect variations in the form of the duodenum. A technic more recently proposed by Buckstein [36] is a modification of that described by Skinner.[33]

Several isolated reports of tumors which had caused enlargement of the duodenal curvatures have been found scattered in the literature. One of these reports [Case [7] (Fig. 10)] concerned a large pancreatic cyst around which the duodenum curved in the shape of a "C", while in Assmann's case [2] (Fig. 385) there is shown a deformity, though not typical, of the loop, by a cyst presenting behind the pyloric antrum and the first portion of the duodenum. In an instance reported by Schwarz [37] a large pancreatic cyst pressing against the greater curvature of the pyloric antrum caused partial pyloric stenosis. It is conceivable that had he used Skinner's method (v.s., [33]) of X-ray visualization, it would have been possible to demonstrate the expansion of the duodenal curvature which was almost certainly present.

In a general discussion of tumors occurring in the region of the head of the pancreas, Püschel [1] (Fig. 8, p. 503) states that not only masses of enlarged sarcomatous lymph nodes, but also those of tuberculous origin, may cause displacement of the duodenal loop. Letulle and Aubourg [38] report an instance in which "lengthening of all the segments of the duodenum was dependent on an enlargement of the duodenal arc" by a mass of tuberculous lymph nodes in the region of the head of the pancreas, while, finally, Assmann [2] (Fig. 663) speaks of the duodenum "stretched out around" a tuberculous mass.

## CONCLUSIONS

(1) An expansion of the duodenal arc should be regarded as an important sign in the diagnosis of immovable tumors in the region of the head of the pancreas.

(2) Lesions of the pancreas itself, however, are not the most common cause of the deformity, for though it is known to be produced by pancreatic cysts of large size and even to be associated with pancreatitis, a carcinoma of the head of the pancreas rarely reaches a sufficient size to do more than cause irregularities in the outline of the loop, as seen by fluoroscopic visualization with barium.

(3) The expansion is most frequently caused by a pathologic process involving the retroperitoneal lymph nodes, such as lymphosarcoma, Hodgkin's disease, metastatic carcinoma or tuberculosis. These lesions usually produce large palpable masses and little or no jaundice, in sharp contrast to the small masses and the early obstructive jaundice which followed the onset of carcinomas of the head of the pancreas.

(4) If there is any doubt as to the pathologic nature of a tumor causing the deformity in question, even should the mass be associated with partial intestinal obstruction or jaundice, operation should be withheld until the effect of radiation has been determined, for many of the lesions producing expansion of the duodenal arc are favorably affected thereby, making operation unnecessary.

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# BENIGN TUMORS OF THE DUODENUM *

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THE rarity of benign tumors in the duodenum as compared with benign tumors of other portions of the gastro-intestinal tract, and the fact that they do not necessarily produce symptoms, are the chief reasons why they are so seldom encountered in surgical practice. They may be responsible for serious symptoms, particularly hæmorrhage; they may be overlooked and they are easily removed; thus they are of significance clinically, and of interest from a surgical standpoint.

King's[1] review of the earlier cases (1917) was based on the report of Heurtaux, who, in 1899, reviewed fifty cases of benign tumor of the intestine. To these King added sixty-nine cases, bringing the total to 119. Of these, five were in the duodenum: one fibroma (Vaccari), one lipoma (Notan-Larrier and Roux), one telangiectatic tumor (Wesener), and two tumors, myomas or fibromyomas (Virchow and Wesener). A case in which two neurofibromas, associated with generalized neurofibromatosis, were found in the duodenum, was also reported; in at least three of the five cases the tumors were found incidentally at necropsy; they had not produced symptoms.

We have noted eight additional cases in the literature and have added four cases of our own. Weishaupt[2] (1916) found an adenomyoma of the duodenum in a child aged eleven days. The glandular structure was similar to that of Brunner's glands. Meisel's[3] case (1921) was an adenomyoma in a woman aged fifty. A diagnosis of duodenal ulcer had been made by the Röntgen-ray. Exploration revealed a small hard tumor within the first portion of the duodenum. The top of the tumor was ulcerated and the base showed round-cell infiltration. The patient was well six months after the operation. Van Tienhoven[4] (1921) reported a case in which slight epigastric distress and a palpable tumor had been noted. Röntgenograms of the stomach did not reveal definite lesions, but strong peristaltic contractions were seen, as in stenosis. At operation a tumor of the duodenum, 6.5 cm. in diameter and weighing 148 gm., was removed; it had encroached on the lumen of the duodenum, producing partial stenosis. The tumor proved to be fibromyoma, springing apparently from the longitudinal muscle of the duodenum. Waugh[5] (1923) found a congenital cyst of the duodenum in a baby aged nineteen days. It was drained but recurred. The baby died from bronchopneumonia following a second operation. Willis and Lasersohn[6] (1925) noted two cases of benign duodenal tumor at opera-

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tion. The first patient was a man aged sixty-three, with a definite history of dull distress in the epigastrium, some nausea and vomiting with loss of appetite and a fifteen-pound loss of weight. Röntgenograms indicated a lesion at the pylorus without obstruction. A well-filled duodenal bulb could not be obtained. At operation a large polypoid pedunculated tumor was found attached to the posterior wall of the duodenum. This could be invaginated up through the pyloric sphincter. Histologic examination proved it to be adenoma, consisting of the structural elements of Brunner's glands. The second tumor was an adenoma of the duodenum about 2 cm. in diameter, which was found during the course of an operation for stone in the common-bile duct. The history of the case was of biliary colic with jaundice. Carman[7] (1921) and Camp[8] (1924) reported two cases of benign tumors of the duodenum. Vogt[9] (1925) reported a case of benign perforating duodenal cyst, but as it was regarded as having arisen from remains of the Wolffian body it has not been included in our list.

Three of the six patients observed at The Mayo Clinic were men and three were women; the ages ranged between twenty-two and fifty. Two of the tumors were myomas, two were adenomas, one was an adenomatous polyp, and one a hemangioma.

REPORT OF CASES.—CASE I.—A woman, aged thirty-six, had experienced recurring mild attacks of pain in the right iliac fossa and a sense of discomfort in that region between attacks. For six months she had noticed indefinite soreness and burning in the upper right side of the abdomen, which usually lasted only a few minutes and was not associated with meals. She was troubled somewhat with belching.

All clinical examinations were essentially negative. Röntgenograms of the stomach were not made. A diagnosis of chronic appendicitis was made and exploration advised. At operation January 17, 1914, a small ulcer was found on the anterior and superior wall of the duodenum, 1.25 cm. below the pylorus. Immediately below this was an irregular, flattened nodule which measured approximately 1 by 2 cm. The nodule was excised and on microscopic examination proved to be adenoma of Brunner's glands. The appendix was removed secondarily. Convalescence was satisfactory, and ten years later the patient reported that she had been free from gastro-intestinal distress since the operation.

CASE II.—An unmarried woman, aged forty-two, gave a history of having had indefinite stomach trouble all her life. Myomectomy for fibromyoma had been performed. Three years before examination she had had a severe gastric hæmorrhage followed at varying intervals by seven others. The last, which had occurred four weeks previously, had been preceded for some time by epigastric pain coming on two or three hours after meals. A blood transfusion had been given the following day.

The general examination was negative. The hæmoglobin was 43 per cent., erythrocytes numbered 3,260,000, leucocytes 6,200 and platelets 246,000. The bleeding time was two minutes and coagulation time (Boggs) eight minutes. The chemical constituents of the blood were normal. The röntgenologist reported duodenal ulcer. Exploration, December 11, 1925, revealed an ulcer on the anterior wall of the duodenum about 1.25 cm. below the pylorus. About 5 cm. below the pylorus was a tumor approximately 2.5 cm. in diameter, involving the anterior wall of the duodenum. The tumor was excised and the opening closed with chromic catgut and silk. The ulcer, with the cap of the duodenum and the anterior part of the pyloric sphincter muscle, was also excised and the opening closed as a gastroduodenostomy.

The pathologist found a linear ulcer (2 cm. by 1 mm.) of the duodenum practically healed and myoma of the duodenum with an ulcerated area on its mucous surface 12 mm. in diameter. Because of the rather large area of ulceration on the myoma and the fact that the duodenal ulcer was apparently healed, it is probable that the tumor was the cause of the previous hæmorrhages. It is possible, however, that the ulcer may have healed following the hæmorrhage four weeks previously. Eleven months later the patient reported that she had gained weight, strength, and color, but occasionally experienced slight distress after eating.

CASE III.—For the last six years a man aged thirty-seven had had periodic attacks of dull gnawing pain in the epigastrium, coming on two or three hours after meals and relieved by food. The attacks lasted several weeks with intervals of from two to six months. The last attack had begun eight weeks before admittance. The pain had been especially distressing for two days (five weeks before examination) when the patient suddenly felt sick and vomited "two quarts" of dark bloody fluid. Since that time he had been on a restricted diet with definite relief.

The patient was twenty-seven pounds under his usual weight. Except for some tenderness in the epigastrium and pyorrhœa, the general examination was essentially negative. The hæmoglobin was 73 per cent., erythrocytes numbered 4,650,000 and leucocytes 7,600. The total gastric acidity was 62 and the free hydrochloric acid 44. Röntgenograms of the stomach and duodenum were negative; those of the teeth showed periapical infection graded 2. A clinical diagnosis of bleeding peptic ulcer was made and exploration advised. At operation March 5, 1927, there was no evidence of ulceration in the duodenum or stomach, but palpation of the duodenum revealed some thickening along its inferior border. An incision made just above this area did not show a break in the mucosa but a definite tumefaction about 1 cm. in diameter which could be picked up with the fingers. This was excised. The appendix was somewhat thickened and was removed. The spleen was of normal size but was slightly adherent to the diaphragmatic surface. Exploration of the gall-bladder, liver, and pancreas was negative.

The pathologist reported adenoma of the duodenum. The immediate convalescence was uneventful and further hæmorrhage has not been reported. The relationship between the duodenal adenoma and the hæmorrhage is, of course, problematic. The spleen must be considered as a possible factor, although splenomegaly was not present. The infection around the teeth may have produced hæmorrhagic erosions in the stomach.

CASE IV.*—A man, aged forty, two years after being partly buried in a gravel pit, noticed that his stools were sometimes dark and tarry. He had dull pain in the epigastrium from one to two hours after meals with some bloating and belching. Eight months previously he had had a severe hæmorrhage and passed numerous large tarry stools. A similar hæmorrhage had occurred two weeks before examination.

The hæmoglobin was 63 per cent., the total gastric acids were 56, and the free hydrochloric acid was 40. Röntgenograms revealed deformity and filling defect of the duodenum suggestive of a papillomatous growth. At operation August 20, 1923, a markedly congested tumor was found in the duodenum. Partial duodenectomy and gastrectomy were carried out, with closure of the duodenal stump and anterior end-to-side gastrojejunostomy following the resection.

Pathologic specimens showed myoma 4 by 3.5 by 3 cm. and an ulcer 1.5 cm. on the mucous surface. In February, 1927, the patient reported that he had remained well.

CASE V.†—A woman, aged twenty-two, had had symptoms of chronic dyspepsia since childhood. During the eighteen months previous to examination two acute attacks of indigestion lasting two days had occurred. Slight nausea and frontal headache followed by sour emesis with relief had also occurred.

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* Previously reported by Camp.
† Previously reported by Carman.

Röntgenograms of the stomach were negative. The duodenum was shadowed as a ring with a translucent centre suggesting a polypoid growth. At operation May 6, 1921, the gall-bladder was normal. Appendicitis was graded 1 and the appendix was removed. The stomach was somewhat thick-walled and dilated. The pylorus was wide open. Just below the pylorus and completely filling the duodenum was a tumor 7 by 5 cm. attached by a sessile base on the duodenal side of the pylorus. Transduodenal excision was made.

The pathologist reported hemangioma. A report on the patient's condition since dismissal has not been received.

CASE VI.—A man, aged fifty, had had a massive gastric hæmorrhage four weeks previously.

Examination disclosed splenomegaly, which was thought to be secondary to cirrhosis of the liver. The total gastric acidity was 20; free hydrochloric acid was not present. Röntgen-ray examination showed duodenal ulcer. At operation February 13, 1923, nodular cirrhosis of the liver was found. The pyloric veins were large, about 1.5 cm. in diameter. Palpation of the duodenum revealed a round pedunculated tumor within the lumen. This was removed and proved to be an adenomatous polyp 0.5 cm. in diameter. The patient recovered satisfactorily but returned a year later because of several severe hæmorrhages from the stomach. Although the splenomegaly suggested possible blood dyscrasia from this source, a diagnosis of hepatic cirrhosis with probable hæmorrhage from œsophageal varices was made.

## TABULATION.

### Summary of Data.

CASE I.—Age 36, female. Symptoms—Burning and soreness in upper right side of abdomen not related to meals; belching; mild attacks of pain in right iliac fossa; duration six months. Clinical and laboratory data—Clinical examination essentially negative. Operative data—1–17–14; irregular, flattened nodule, 1.2 cm. by 1.8 cm. on anterior superior wall of duodenum 1.2 cm. below pylorus; small ulcer immediately above it. Operation—Nodule and ulcer excised; appendectomy. Pathologic report— Ulcer on adenoma of Brunner's glands. Comment—No gastro-intestinal distress ten years later.

CASE II.—Age 42, female. Symptoms—Eight gastric hæmorrhages (some of them severe); the last one four weeks before examination was preceded by epigastric pain two or three hours after meals; duration three months.* Clinical and laboratory data— Hæmoglobin 43 per cent.; erythrocytes 3,260,000; leucocytes 6,200; platelets, 246,000. Röntgenologic data—Duodenal ulcer. Operative data—2–11–25; ulcer on anterior wall of duodenum 1.2 cm. below pylorus; tumor 2.5 cm. in diameter, 10 cm. below pylorus. Operation—Excision of ulcer; excision of tumor. Pathologic report—Practically healed linear ulcer 2 cm. by 1 mm.; myoma 3 by 2 cm. with 12 mm. of ulceration on mucous surface. Comment—Reported gaining weight and strength eleven months later, color better, occasionally slight distress after eating, one slight hæmorrhage.

CASE III.—Age 37, male. Symptoms—Periodic attacks of dull pain in epigastrium two to three hours after meals relieved by food, last attack five weeks before examination; vomited 1,892 c.c. of bloody fluid; duration six months. Clinical and laboratory data—Hæmoglobin 73 per cent.; erythrocytes, 4,650,000; leucocytes, 7,600; total acidity 62; free hydrochloric acid 44. Röntgenologic data—Stomach and duodenum normal; dental infection. Operative data—3–5–27; "definite tumefaction" about 1 cm. in diameter in duodenum; no break in mucosa; further exploration of abdomen negative. Operation—Excision of tumor of duodenum; appendectomy. Pathologic report—Adenoma. Comment—Immediate convalescence uneventful, not heard from after going home.

CASE IV.—Age 40, male. Symptoms—Tarry stools at times; dull pain in epi-

* Transfusion.

gastrium two hours after meals with belching; two severe hæmorrhages eight and a half months before examination; duration two months. Clinical and laboratory data—Hæmoglobin 63 per cent.; leucocytes 5,900; total acidity 56; free hydrochloric acid 40. Röntgenologic data—Filling defect in duodenum suggestive of papillomatous growth. Operative data—8–20–23; congested tumor 2.5 cm. in diameter in duodenum. Operation—Pylorectomy (Balfour-polya). Pathologic report—Myoma 4 by 3.5 by 3 cm., with ulcer 1.5 cm. on mucous surface. Comment—Had remained well four years later.

CASE V.—Age 22, female. Symptoms—Some chronic dyspepsia, nausea, vomiting and headaches since childhood; in last eighteen months two acute attacks of crampy pain in upper part of abdomen with vomiting, lasting two days; duration one and a half months. Clinical and laboratory data—Hæmoglobin 65 per cent.; erythrocytes 3,920,000; leucocytes 7,300; total acidity 36; free hydrochloric acid 22. Röntgenologic data—Stomach normal, duodenum shadowed as ring with a translucent centre suggesting polypoid growth. Operative data—5–6–21; tumor 7 by 5 cm. filling duodenum, attached by a sessile base on duodenal side of pylorus. Operation—Excision of tumor. Pathologic report—Hemangioma. Comment—No report from patient six years later.

CASE VI.—Age 50, male. Symptoms—Some indigestion all of life; alcoholism; massive gastric hæmorrhage four weeks previously; duration four weeks. Clinical and laboratory data—Hæmoglobin 63 per cent.; erythrocytes 3,720,000; leucocytes 3,200; total acidity 20; no free hydrochloric acid; splenomegaly thought secondary to hepatic cirrhosis. Röntgenologic data—Duodenal ulcer. Operative data—2–13–23; cirrhosis of liver, pyloric veins about 3 mm. in diameter; pedunculated tumor in duodenum. Operation—Excision of tumor. Pathologic report—Adenomatous polyp 0.5 cm. in diameter. Comment—Reëxamined one year later; several severe gastric hæmorrhages; cirrhosis of liver with œsophageal varices.

### COMMENT

In all but one of the six cases symptoms seem to have been accounted for by the presence of the tumor. The most significant sign was hæmorrhage, which was severe in four of the six cases. In one of these, however, the hæmorrhage was afterward proved to have been due to other causes.

In five of the six cases some form of indigestion was present. In three of these it had simulated somewhat the ulcer type. In one a small duodenal ulcer may have produced the symptoms. In one not associated with ulcer sufficient time has not elapsed since operation to determine the significance of the tumor in the production of the symptoms. A tumor was not noted on examination in any case. In only one case also was definite obstruction present. This is in sharp contrast to benign tumors elsewhere in the small bowel which usually first attract attention by producing intussusception. The tumor was ulcerated in three of the seven cases; in two of these hæmorrhages were severe.

A diagnosis of benign tumors of the duodenum can be made only by the Röntgen-ray. Unless the tumors are large, however, it is difficult to visualize them on account of the rapid passage of the medium through the small bowel. Two of the tumors in the series were diagnosed as such by the Röntgen-ray. While gross gastric hæmorrhage or melena should suggest the possibility of benign duodenal tumor, other intragastric and duodenal lesions which may have produced it are so much more common that this is indeed a remote possibility. So far as we have determined, an instance of such a tumor having undergone malignant degeneration has not been reported.

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# DUODENAL DIVERTICULA AND THEIR SURGICAL TREATMENT

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A comprehensive search of the literature by Baldwin,[3] Buschi,[4] Wilkie,[25] Fischer,[10] and other writers shows that prior to the year 1912 the known number of cases of duodenal diverticula did not exceed one hundred.

Case,[6] of Battle Creek, was probably the first to diagnose the condition by X-ray examination, and in 1913 reported four cases at the Scientific Exhibit of the American Medical Association. In 1920 he reviewed the literature to that date, reporting a series of eighty-five cases. He also described his X-ray technic of diagnosis and reported a number of operative results.

Following the X-ray recognition of the condition a great many cases were reported, including a large series in England by Spriggs and Marxer,[22] Cole,[8] Larimore and Graham,[15] Cryderman,[9] and others, as well as many in foreign literature.

Grant [12] in 1922–1923 reported the occurrence of duodenal diverticula to be 16.2 per cent. in thirty-seven cases examined. He used the cadaver in the dissecting room and demonstrated the diverticula through the method of injecting paraffin into the duodenum. Baldwin, in a series of 105 cases, was able to demonstrate the condition in 13.3 per cent.

Linsmayer [16] found the condition in 3 per cent. of 1367 necropsies as did Rosenthal [20] in a series of one hundred cases.

By X-ray examination Case found duodenal diverticula in 1.2 per cent. of all cases having complete gastro-intestinal examination by means of barium, and McMillan reported 1.5 per cent. in his series. Andrews [1] likewise reported 1.2 per cent. In my own series the condition has been recognized in a little over 1 per cent. of cases examined. These figures indicate that the condition is not recognized nearly as frequently as it should be.

There has been a great deal of discussion as to whether the condition is congenital or acquired, and much evidence has been advanced to support both views. As the embryological development of the duodenum is very complex one would expect this portion of the intestinal tract to be prone to developmental defects, and duodenal diverticula has been recorded a number of times in necropsies of infants. The X-ray recognition of the condition has been confined to adults—Spriggs and Marxer have watched small diverticula, under repeated examination, over varying intervals of time, grow from the size of a pea to that of a walnut. They are satisfied from their observations that by X-ray examination they have recognized in the colon a pre-diverticula stage consisting of local inflammatory areas which, if untreated, give rise to diverticulitis. The condition is almost always recognized in patients past middle life and quite conceivably occurs in areas weakened

Fig. 1.—Diverticulum of the second part of the duodenum from the inner border.

Fig. 2.—Diverticulum of the first part proximal to a duodenal ulcer.

by local inflammation as a result of local strain and stress to which the part may have been subjected. Careful consideration of the subject seems to indicate that the condition may be either congenital or acquired.

There is as yet no symptom complex by which a duodenal diverticulum may be diagnosed without recourse to X-ray examination. In all patients complaining of obscure upper abdominal symptoms the condition should be kept constantly in mind. Many of the cases recorded have suffered for years from distress and pain, and not a few have been operated for some other condition before their lesion was diagnosed. Many cases of acute



FIG 3—Diverticulum of the second part of the duodenum from the outer border.

diverticulitis have been reported, the condition having been recognized when operation was undertaken for acute cholecystitis or perforating ulcer. Perforation of the diverticulum according to Monserrat,[18] and as demonstrated in one of the cases herewith reported, occurred prior to operation. Hæmorrhages have occurred in two of the series of cases reported by Spriggs and Marxer. Two of my own series gave a previous history of severe hæmorrhage. In the cases reported by Spriggs and Marxer 47 per cent. produced symptoms which could not be explained by any other pathology.

A feeling of fulness or distension is a symptom frequently described. One of our patients in discussing her symptoms said she felt at times that something was about to burst in her epigastrium, though she did not suffer from distension or bloating. Aching and severe attacks of pain radiating through to the back and simulating biliary colic are common. Nausea and

vomiting at intervals over a period of years, together with marked loss of weight, have been frequently noted. At times tenderness is found on palpation over the diverticulum, especially at the time of the X-ray examination. Smithies [21] says that he has observed no cases which presented a typical history of duodenal ulcer. Several of the cases reported herewith gave a classical history of duodenal ulcer and were so diagnosed by the clinician prior to X-ray examination.

Claremont and Schinz [7] report six cases, all producing symptoms, in five of which the diverticulum was the cause. Two of these were treated surgically. Butler and M. Ritvo [5] report four cases, two of which were operated, one being entirely relieved of symptoms. No follow-up record of the other case was found.

In cases reported by Moore,[19] Forsell and Key,[11] and Basch [2] operative removal of the diverticulum resulted in apparent cure of symptoms.

Larimore and Graham have reported a number of cases of duodenal diverticula which were associated with cholecystitis; cholecystectomy relieved the symptoms. Case reported cases in which cholecystectomy or gastro-enterostomy relieved the symptoms, as well as cases in which the diverticulum was removed resulting in cure.



FIG. 4.—Diverticulum of the second part of the duodenum from the inner border.

Hartung [13] reported a case in which the patient was explored by the surgeon and the diverticulum not being found, appendectomy was performed. The symptoms persisted and subsequent X-ray examination again demonstrated the presence of a diverticulum. He also reported five cases which improved on medical treatment. Spriggs and Marxer reported many of their cases as being improved on medical management.

Sir Harold Stiles [23] removed a duodenal diverticulum two and one-half inches long, resulting in relief of symptoms. Maclean reported a series of sixteen cases, four of which were operated, three with entire success. The last case was operated too recently to report end results. In two of his cases peri-diverticulitis was marked at operation and in one peri-duodenitis was the outstanding feature. He gives a full description of the operative technic employed for the exposure of the diverticulum and his method of dealing with the sac, having been unable to find any technic so far described in any book on operative surgery.

Thompson [24] in 1926 reported the only case we have found of diverticulum of the stomach. The case was explored for gastric pain and vomiting and an adhesion from the cardia to the pylorus was cut, nothing else being found to account for the symptoms. As the patient did not improve he was again X-rayed and the diverticulum recognized on the posterior wall, an inch below and internal to the cardiac orifice. This was dealt with at a second operation and the patient was cured of his symptoms.

Kenard and Vandel [14] reported a case with a history extending over fifteen years, characterized by severe pain and loss of weight; surgical interference brought relief and gain of eight pounds in weight.

## REPORT OF CASES

CASE I.—A. T., male, aged sixty-three years, blacksmith, weight 175 pounds. Came under observation in April, 1926. The patient gave a twenty-year history of stitch-like pain in the epigastrium, chiefly under the left costal arch. The distress at the onset was of short duration, half to one hour, becoming gradually progressive until the attacks would last two to three days. For the past eight to ten years the distress was almost constant, and at times the pain was severe, but did not simulate gall-stone colic. There was no food relationship, but if the patient ate meat he would often vomit it. Bowels regular.

Physical examination was negative except for left inguinal h e r n i a. Test meal: total acidity 35; free hydrochloride 30. X-ray showed stomach and duodenal bulb normal. Large diverticulum second portion duodenum.

At operation the surgeon could not locate the diverticulum, although he mobilized the entire first and second portion of the duodenum, encountering fairly free hæmorrhage from some of the mesenteric blood vessels. There was an area of thickness and induration extending into the head of the pancreas, but it could not be clearly defined



FIG. 5.—Diverticulum. (Same as Fig. 4.)

as the diverticulum without a great deal more dissection than was thought advisable and as there was a cholecystitis, grade II; cholecystectomy was performed. Further experience has convinced us that if dealing with a similar case and the diverticulum could not be readily exposed, we would at once incise the duodenum in the area where the radiologist had localized the diverticulum, and having found the stoma with a finger in the sac as a guide, dissect it free from its surroundings.

When this patient left the hospital, X-ray demonstrated the diverticulum as before. The patient was seen one year later, still complaining of epigastric distress with excessive gas formation and bloating, necessitating that he loosen his clothing. He also suffered from an occasional vomiting spell. It has been learned that this patient has a private still and alcoholic gastritis may, and probably does, account for much of his distress.

CASE II.—R. S., male, aged twenty-eight years, came to the Lockwood Clinic in September, 1927. For several years the patient had suffered from spells of gastric distress lasting a few days, followed by similar intervals free from pain. The condition had become practically chronic during the past year, the distress coming on several hours after meals and being definitely relieved by food and alkalies. There was excessive gas formation with belching, but no bloating. Soreness had developed during the past year, radiating from the right costal margin to the back, but no history of acute colic was given.

Physical examination was negative. Test meal: total acidity 81; free hydrochloride 70. Clinical diagnosis: duodenal ulcer. X-ray examination: duodenal ulcer with diverticulum of the first part of the duodenum.

Operative diagnosis: Sub-acute duodenal ulcer with diverticulum 3 x 2 cm. proximal to the ulcer, and chronic appendix.

Operation: Gastro-enterostomy and appendectomy, inversion and oversewing of the diverticulum.

The patient made a satisfactory recovery and has been relieved of his symptoms.

CASE III.—R. K., female, aged thirty-four, came for examination in September, 1927. She gave a history of abdominal distress and discomfort for the past twelve years with three or four attacks of "gastritis," each attack confining her to bed for about two weeks. Epigastric pain was a prominent symptom and mustard plaster was used over the abdomen for relief. Eating increased her distress. She had nausea but no vomiting during the attack. In 1918 she had been operated on elsewhere for chronic appendix and in 1920 right nephropexy was performed by the same surgeon.

Physical examination was negative. Clinical diagnosis: chronic nervous exhaustion, but because of previous spells of gastritis a test meal and stomach X-ray were advised. Test meal: total acidity 21; free hydrochloride 13. X-ray examination showed the stomach and duodenal bulb negative. There was a large diverticulum on the free border of the second portion of the



FIG. 6.—Loculated diverticulum of the second portion of the duodenum.

duodenum. Operation was advised and carried out, the diverticulum being excised and the stump inverted. Gall-bladder normal. This patient had a stormy convalescence and when seen on several occasions at intervals of some months, while feeling better, was still complaining of gastric discomfort. In a recent letter answering a questionnaire, she says: "My appetite is good, I am feeling pretty well and gaining in weight."

CASE IV.—G. M., male, aged sixty-five years. Seen for the first time in November, 1927. He gave a history of attacks of epigastric distress for nine years, the first lasting six weeks. Blood was vomited once during this attack. The second attack, six years ago, lasted two weeks; and at this time the stools were black and tarry for several days. He had suffered a third attack six weeks previous to coming to the Clinic, during which epigastric soreness or distress came on two hours before meals and at times hunger pains at 2 A.M. No discomfort was experienced while adhering strictly to a light diet and masticating his food well. Between spells there was entire freedom from symptoms.

Physical examination was negative. Clinical diagnosis: duodenal ulcer—gall bladder. Test meal: total acidity 61; free hydrochloride 48. X-ray examination: stomach and duodenal bulb negative, large diverticulum second part of duodenum.

The patient was put on Sippy diet, and remained on this three months free from distress, but losing weight. He then began to eat more liberally and developed severe epigastric pain, associated with bloating. Vomiting was induced for relief afforded— very tender over epigastrium. Three attacks in ten days, requiring morphia and codeine to control the pain. Hæmoglobin had dropped from 89 per cent. to 64 per cent. and the red blood count to 3,100,000.

Operation February 29, 1928. The surgeon reported: 1. Chronic cholecystitis with cholelithiasis. 2. Acute inflammatory lesion, second portion of duodenum, perforating into the head of the pancreas and well walled off with adhesions. It was impossible to undertake any dissection of the duodenum itself because of the sub-acute nature of the adhesions at the site of perforation. 3. Chronic appendix.



FIG. 7.—Large diverticulum of the first part proximal to a duodenal ulcer.

Cholescystectomy, appendectomy and post-gastro-enterostomy were performed. This patient when last seen was entirely free of symptoms.

CASE V.—J. C., male, aged sixty-three years, came to the Lockwood Clinic November 23, 1927. His chief complaint was stomach trouble from which he had suffered for the past two months, never having had any previous distress. The patient complained of a hungry feeling associated with pain two hours after meals, and was occasionally wakened at night. The distress was eased by food and alkalies.

Physical examination was negative. Clinical diagnosis: duodenal ulcer. Test meal: total acidity 38; free hydrochloride 48. X-ray examination: stomach and duodenal bulb negative. Diverticulum second portion of the duodenum.

The case was treated medically and up to the present time the patient has been relatively free from symptoms while adhering to a strict diet.

CASE VI.—A. E., female, aged forty, came to the Clinic in January, 1928. She gave a history of nineteen years of abdominal distress and pain mostly in the epigastrium. Nineteen years previously she had been operated upon for chronic appendicitis. Thirteen years ago, when four months pregnant, she had a post-gastro-enterostomy for clinical diagnosis of duodenal ulcer. Four years ago internal shortening of round ligaments.

Her chief complaint at the time of her examination was of a constant, aching pain under the ribs on the right side, radiating through to the shoulder, often with a feeling as if something were going to burst in the epigastrium. Belching of gas +++; bloating ++; could obtain no history suggestive of duodenal ulcer at any time. Had been X-rayed twice recently and been told that there was no evidence of any duodenal ulcer and that it was doubtful if she had had a gastro-enterostomy, as there was no evidence of a stoma. The clinician who examined the patient made a provisional diagnosis of cholecystitis.

Test meal: total acidity 36; free hydrochloride 23. X-ray examination showed a gastro-enterostomy opening very high on the posterior wall of the stomach. The

duodenal bulb filled well and there was no evidence of ulcer. Large diverticulum of second part of duodenum.

The patient was put on medical management for three months, but as her symptoms did not respond to treatment, operation was advised and carried out in April.

A large diverticulum of the second portion of the duodenum projecting into the pancreas was dissected out, cut off, and the opening in the duodenum closed with two rows of chromic catgut.

As there was no evidence of any ulcer in the bulb, the gastro-enterostomy was cut off and the gall-bladder removed because of a low grade cholecystitis.

I interviewed this patient recently and she said her operation had been well worth while. She was entirely relieved from her gastric distress and was free from the sensation of something about to burst in her epigastrium. She was eating well and gaining in weight.

CASE VII.—J., male, aged sixty-eight, came to the Clinic in February, 1928. He gave a history of stomach trouble for forty years, recurring in spells of two to four weeks' duration with long intervals of freedom. The attack began with a sense of distress or discomfort—no pain—always on an empty stomach, and was relieved by food and alkalies. He had frequent night pain. During the past six years he vomited often, with increasing frequency during the past two years, usually on lying down at night. Occasional retention vomit. Bloating ++. Tarry stools?



FIG. 8.—Diverticulum of the third part of the duodenum from the inner surface.

Physical examination was negative except for grade II enlargement of the prostate. Clinical diagnosis: duodenal ulcer with obstruction. Test meal: total acidity 52; free hydrochloride 40. X-ray examination: No. II retention of barium meal and duodenal ulcer with diverticulum proximal to the ulcer.

The surgeon's findings corroborated the clinical diagnosis and a post-gastro-enterostomy was done, no attempt being made to do anything to the diverticulum.

The patient made an uneventful recovery and at the time of his dismissal was free from symptoms. However, on the first of July last his home doctor wrote us that he was again poorly—that he had upper abdominal distress and vomited large quantities of bile. I wrote this patient about the end of August, and he said that on returning home he had developed an ischiorectal abscess and was very miserable until this cleared up. At the time of writing he was feeling fine, had no gastric distress and was eating well.

CASE VIII.—W. N., male, aged fifty-eight years, admitted July 12, 1928. The patient gave a clinical history of periodic spells of epigastric distress for twenty years past, beginning with a sense of fulness and discomfort with some regurgitation, and later, about 1912, developing attacks of severe pain. In 1921 he suffered from free gastric hæmorrhages, vomiting large quantities of bright red blood and passing tarry stools for some days. He was confined to bed for two months and kept on a diet of egg and milk

for one year. The feeling of moderate fulness and discomfort continued from then until two months before his admission to the Clinic, at which time he had developed severe pain in the mid-epigastrium, radiating through to the back, on one occasion requiring morphine to control the pain. So distressing was his sense of fulness at night that he could only sleep in a sitting position and often lay on his stomach on a hot water bottle for relief. Former X-ray diagnosis of duodenal ulcer.

Physical examination showed moderate epigastric tenderness. Diagnosis: 1. Duodenal ulcer of perforating type. 2. Cholecystitis. Test meal: Total acidity 75; free



Fig 9.—A small diverticulum of the second part.

hydrochloride 65. X-ray examination: stomach and bulb negative. Large diverticulum of the third portion of the duodenum.

Operation: Cholecystectomy and appendectomy performed, the surgeon reporting grade III cholecystitis with definite evidence of previous trouble in the appendix.

The duodenum was explored for the diverticulum but as it could not readily be exposed in view of pathology already found, it was not considered advisable to undertake the dissection necessary to locate it. Later experience has taught us that the best approach to a diverticulum located in this area is secured as suggested by Maclean by retracting the colon upward and making an incision through the meso-colon in an endeavor to locate the diverticulum by blunt dissection.

An interesting point in this patient's history was the fact that he could not sleep lying down, but could do so in a sitting posture, this being the position best suited for gravity drainage of the sac of the diverticulum.

CASE IX.—G. A. B., female, aged fifty-one years, seen for the first time June 22, 1928. According to the history given by the patient she had, about 1919, developed an acute attack of severe pain in the right upper quadrant. The pain and tenderness lasted

one day. Appendectomy and cholecystectomy were performed in 1920. The patient felt better for from three to six months. She was then operated for post-operative hernia. Since then she had had more or less chronic epigastric distress, with spells when distress and pain were more marked. Pain radiated through from under the right costal margin to the right shoulder. Distress and soreness were more marked two to three hours after meals, and about 4 A.M. Alkalies gave some relief, but food did not seem to give relief.

Physical examination was negative except for tenderness in right upper quadrant. Diagnosis: duodenal ulcer and chronic cholecystitis. Test meal: total acidity 86; free



Fig. 10 —Large diverticulum of the second and also of the third portion of the duodenum.

hydrochloride 68. X-ray examination: gall-bladder—Graham-Cole technic—negative. X-ray of stomach: duodenal ulcer with moderate sized diverticulum of second part on inner border.

Sippy management tried for one month with slight improvement.

Cholecystectomy and post-gastro-enterostomy were performed July 19th. No endeavor made to find the diverticulum.

CASE X.—H. T., female, aged seventy-eight years, seen for the first time in June, 1928. She gave a history of stomach trouble off and on for twenty years with attacks of one to two weeks' duration until about three years ago. Distress since then was more or less chronic. Pain came on one hour after meals and was definitely relieved by food. Vomiting ++ had occurred about two weeks previous to admission.

Physical examination showed moderate tenderness over the epigastrium. Clinical diagnosis duodenal ulcer. Test meal: total acidity 60; free hydrochloride 38. X-ray examination showed No. I gastric retention and large diverticula of second and also of the third portion.

This patient was kept on ulcer diet and alkalies for about two months, with only slight relief from symptoms. Finally she asked to be operated on as she felt that something must be done to obtain relief. At operation a large diverticulum of the second part dissecting into the head of the pancreas was readily located by opening the duodenum and with the finger in the diverticulum, it was a comparatively easy matter to free it prior to excision. The large diverticulum of the third part was approached by retracting the colon upward, incising its mesentery and by a little blunt dissection locating the sac. These diverticula were both very large, being quite as big as an average hen egg. While it is early yet to judge of end results, the patient has had a remarkably easy convalescence and is very grateful for the relief she has experienced.

## SUMMARY

Diverticula of the œsophagus, colon, Meckel's diverticula and bladder diverticula have for years been operated successfully for relief of distressing symptoms. Duodenal diverticula do not seem to have received the same surgical recognition which the severity of the symptoms noted seem to warrant. Large diverticula often show evidences of retention of barium from twenty-four hours to six or seven days. They are always discovered on routine X-ray examination, usually under the fluoroscope in adult patients, presenting themselves because of upper abdominal distress from which they seek relief. The condition should be constantly kept in mind when no other diagnosis can be made to account for the patient's symptoms as evidence would seem to show that it occurs much more frequently than is generally realized. When recognized by X-ray, medical management may at times be tried with marked relief if the symptoms are not urgent.

Cholecystectomy, gastro-enterostomy or excision of the diverticulum have all been performed by different surgeons with apparent cure. The method employed in a given case must depend on conditions found at the operating table combined with the judgment of the surgeon and his skill in dealing with the difficult surgical problems of the upper abdomen. In our cases the best results have followed excision of the diverticulum.

The difficulty experienced by the surgeon in locating diverticula at operation calls for accurate localization on the part of the radiologist. The majority of duodenal diverticula occur in the second portion. They practically always occur through the posterior wall where it is not covered by peritoneum, this increasing the difficulty in locating them at operation.

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# AFFECTIONS OF THE APPENDIX IN YOUNG CHILDREN *

## A REVIEW OF 100 CASES.

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AFFECTIONS of the vermiform appendix in infants and the younger group of children is taken up for consideration because most authors have emphasized the following points: (1) the immunity of nurselings to appendicular disease, (2) its relative rarity in early life, (3) the difficulty of diagnosis, owing to the insidious onset and the obscure clinical picture; (4) the tendency to early perforation, with rapid spread of inflammation and overwhelming ·toxemia; and (5) the high mortality in the first half decade of ·life.

Many isolated case reports refute the statement that nurselings are immune to appendicitis. It has even been found in the first week of life on several occasions. Its rarity in early life has been too greatly emphasized. While relatively rare, it is by no means uncommon under five years of age, as increasing evidence goes to prove.

The diagnosis of appendicitis may be and often is a difficult problem at any age, but it is peculiarly so in infants and very young children. The emphasis placed on the rarity of this disease is such that in subjects under two years of age it is often not even thought of, and is overlooked altogether in all but the worst of cases. Another reason why it is sometimes unrecognized is because of failure to make a systematic and thorough physical examination. Even when one is on the alert there are certain instances where the picture is so baffling and the examination so puzzling or misleading or negative that a diagnosis is delayed or not made at all. Naturally, the younger the patient the more difficult is the diagnosis. Fortunately, however, in the majority of cases, and especially so as age increases, the clinical picture is just as clear-cut and characteristic and as easy to interpret and the physical examination as satisfactory as in adults.

Certain anatomical anomalies and variations help to explain why appendicitis is such a serious disease in early childhood. The cecum may not have rotated or descended normally. The appendix itself is relatively much larger, longer, more funnel-shaped, contains a larger proportion of lymphoid tissue and is much more delicate in structure. Its position is less constant, usually being located above McBurney's point. It may be found anywhere in the abdomen,—in the pelvis, under the liver or well over on the left side. Occasionally it may be held fixed by a vestigial band or fold, or it may be retrocecally placed and completely buried. When perforation of an inflamed appendix occurs, the delicate omentum, often veil-like in thinness, offers but a feeble barrier to the spread of inflammation. Knowing these anatomical

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differences, it is easy to understand why appendicitis is much more insidious in onset, the spread of inflammation more rapid, the intoxication more over-powering,—in short, it is not difficult to see why the disease is so serious in the very young. On the other hand it is not reasonable to conclude that the tendency to perforation, abscess formation or spreading peritonitis is the rule at this period. It is far more probable that the majority of cases, undiag-nosed it is true, go on to spontaneous recovery. Many cases of indigestion-colic, gastritis, gastro-enteritis, acidosis, cyclic vomiting, etc., and many acute infections, accompanied by abdominal symptoms (pain, vomiting, fever, etc.) are in reality instances of unrecognized appendicular disease. In every attack of acute abdominal pain it is a safe rule to assume that the appendix may be involved and then procede to verify or rule out this suspicion. The habit of deciding that such disorders are due to dietary indiscretions and that a purgative will relieve the indigestion-colic is responsible for many deaths.

The mortality in acute appendicitis in early life is extremely high. All observers are in accord on this point. In nurselings it is over 70 per cent. In eighty cases under two years of age collected from the literature by Abt, the mortality was 50 per cent. Under six years the mortality is variously estimated as from 15 to 40 per cent. Such a death rate is too high! It means failure to recognize the disease early, or delay in instituting surgical treat-ment, or gross mismanagement in administering purgatives, when the diag-nosis is in doubt. Purgation and procrastination are responsible for the majority of deaths.

In statistical reviews on the subject of appendicitis in children the age limit is usually placed at from twelve to fourteen years. For convenience the patients can be arranged into two groups,—the first embracing all patients up to and including the sixth year, and the second group including all the older children. This paper will be limited to a discussion of the younger group. Generally speaking, older children present fewer problems in diag-nosis and show a morbidity and mortality rate which compares favorably with that of adolescents. In fact, in the experience of the writer his results have been more generally favorable at this than at any other period of life.

A series of 100 cases, personally operated upon by the writer, supplies the data for such impressions and comments as are embodied in this paper. In the majority of instances the findings at operation and the laboratory reports were in accord. Occasionally, the clinical symptoms and the macro-scopic anatomical picture did not agree with the laboratory findings and diagnosis. No case has been included in this review, however, in which the laboratory gave a normal or negative report.

The age incidence in the series is of interest: under twelve months, eight cases, all associated with acute intussusception; from one to two years, five cases; from two to three years, ten cases; from three to four years, nine cases; from four to five years, eighteen cases; from five to six years, twenty-three cases; and in the sixth year, twenty-seven cases. Males were affected in seventy-one and females in twenty-nine instances. Seventy-five per cent.

of the cases were diagnosed as acute or subacute appendicitis and 25 per cent. were of the chronic variety. The former ranged from mild acute catarrhal appendicitis to the very worst types of gangrenous appendicitis, with abscess, or more or less widespread peritonitis. The chronic cases, for the most part, gave histories, which suggested previous mild acute attacks of appendicitis: fourteen were associated with hernia, one with acute intussusception, one with tonsillitis, three with tuberculous mesenteric lymphadenitis, and two with pinworm infestation of the appendix.

There were six deaths among the 100 patients operated upon, giving a mortality of 6 per cent. There were no deaths in twenty-three cases ranging in age from four months up to two and seven-twelfths years of age. There were two deaths between three and four years, two deaths between four and five years, and two deaths between five and six years. Contrary to popular teaching, young subjects show remarkable resistance in combating appendicitis. There is practically no mortality in early and properly handled cases, and the mortality is far less than one would expect in the late and obviously mismanaged ones.

*Intussusception and Appendicitis.*—For some years appendicectomy has been advocated when operating for acute intussusception in children. This was due to a belief that a causative relationship existed between appendicitis or appendicular irritation and acute intussusception in a certain proportion of cases. In our early experience the condition of the appendix was noted, but no pathological study was made of this organ. In more recent years, however, all such appendices have been sent to the laboratory for pathological examination, and it is interesting to note how often the specimens show definite evidence of disease. When the appendix is caught in the invagination, trauma unquestionably influences the pathological picture. But when the appendix is not actually involved in the invagination process, and is in no way traumatized, how then can the frequent association between acute intussusception and an inflamed appendix be explained? It is the conviction of the writer that appendicitis is one of the common causes of intussusception.

*Hernia and Appendicitis.*—In examining children with right inguinal hernia, the presence of a thickened tender appendix in the hernial sac was detected in several instances. On two occasions, at operation, the diseased appendix was found adherent in the sac and irreducible. Every surgeon at some time or other has probably encountered acute appendicitis associated with right inguinal hernia. The history and physical examination in hernia patients will frequently suggest appendical disease, and one can often prophesy beforehand and verify at operation this suspicion. Many times has a parent brought a child for operation on account of the discomfort supposed to be caused by a rupture, when in reality the distress was occasioned by a diseased appendix. In a child appendicitis should always be suspected when a hernia gives subjective symptoms of any kind. So frequently are hernia and appendicitis associated that this combination can hardly be dismissed on

the grounds of coincidence. It is the exception to find a normal appendix in a child who has had a hernia, unsupported by a truss, for any considerable period of time. The longer the hernia has existed the more probable it is that a complicating appendicitis is present.

*Chronic Appendicitis.*—The statement often made that chronic appendicitis is a non-existant condition or a very rare lesion in early life is not borne out in a study of this series of cases. Twenty-five cases were classed as "chronic," "healed" or "healed purulent" appendicitis. Recurring attacks of abdominal pain, usually of short duration, with nausea, with or without vomiting, and with slight fever, are the chief characteristics of the clinical picture.

TABLE I—*Fatal Cases*

| Age | Sex | Time sick before operation | Additional diagnosis | Time bet. operation and death | Apparent cause of death |
|---|---|---|---|---|---|
| 3 years | M. | 5 days | Multiple abscess and general suppurative peritonitis | 4 days | Paralytic ileus and sepsis |
| 3½ years | M. | 5 days | Abscess | 14 days | Fecal fistula, sepsis and exhaustion |
| 4 years | M. | 3 days | General suppurative peritonitis | 13 hours | Sepsis |
| 4 years | F. | 10 days | Rupture of localized abscess with general peritonitis | 3 days | Sepsis |
| 5 years | F. | ? | Spreading peritonitis | 7 days | Sepsis |
| 5-9/12 years | M. | 4 days | General suppurative peritonitis | 5 days | Sepsis |

Point or localized tenderness, in the absence of abdominal sensitiveness elsewhere, is an important objective sign. The surgeon is warranted in doing an exploratory operation, if, after a thorough study of the case, including an X-ray examination of the gastro-intestinal and genito-urinary tracts, other conditions which might be confused with appendicitis can be eliminated.

The symptomatology, diagnosis and details of the surgical treatment of acute appendicitis will not be taken up in this article. It may not be amiss, however, again to mention that in the differential diagnosis it is of the utmost importance to exclude pleural, pulmonary and even meningeal inflammations. A circumscribed or central pneumonia or a diaphragmatic pleurisy, without physical signs, may be mistaken for appendicitis. The minutest attention to details is necessary in order to avoid errors. Other medical conditions which

may cause confusion or doubt are (1) gastro-enteritis, (2) acute right-sided pyelitis and (3) occasionally Henoch's purpura. Among the surgical conditions to be borne in mind are (1) intussusception and other types of intestinal obstruction, (2) mesenteric lymphadenitis, (3) peritonitis not due to appendicitis, (4) inflamed or adherent Meckel's diverticulum, (5) stone or inflammation, affecting the right kidney or ureter, (6) pelvic disease in females (salpingitis, or inflammation or growth of the right ovary), (7) inflamed or twisted right undescended testicle, (8) duodenal ulcer, (9) psoas abscess, (10) infections of the right hip-joint, etc. Appendicitis, too, may complicate or be associated with tonsillitis, influenza, pneumonia, measles,

TABLE II

*Intussusception and Appendicitis.*

| Chart No. | Name | Sex | Age | Diagnosis | Result |
|-----------|------|-----|-----|-----------|--------|
| 26323 | Rosario R. | M. | 4 mos. | (1) Intussusception, acute<br>(2) Appendicitis, acute | Recovery |
| 35003 | Louis V. | M. | 4 mos. | (1) Intussusception, acute<br>(2) Appendicitis, gangrenous | Recovery |
| 14033 | Christine A. | F. | 7 mos. | (1) Intussusception, acute<br>(2) Appendicitis, acute, and acute peri-appendicitis. | Recovery |
| 34810 | Joyce P. | F. | 7 mos. | (1) Intussusception, acute<br>(2) Appendicitis, subacute purulent and purulent peri-appendicitis. | Recovery |
| 5967 | Bernard S. | M. | 8 mos. | (1) Intussusception, acute<br>(2) Acute congestion of appendix and chronic peri-appendicitis. | Recovery |
| 21658 | Harry K. | M. | 8 mos. | (1) Intussusception, acute<br>(2) Appendicitis, chronic, with congestion and swelling of mucosa, and hyperplasia of lymph follicles. | Recovery |
| 5389 | Seymour K. | M. | 8 mos. | (1) Intussusception, acute<br>(2) Appendicitis, acute | Recovery |
| 13519 | Gerald S. | M. | 10½ mos. | (1) Intussusception, acute<br>(2) Appendicitis, subacute | Recovery |
| 7558 | Max W. | M. | 17 mos. | (1) Intussusception, acute<br>(2) Appendicitis, acute | Recovery |
| —— | Helen R. | F. | 4-1/6 yrs. | (1) Appendicitis, acute<br>(2) Intussusception, acute, enteric. | Recovery |

typhoid fever, and the various affections before mentioned. One should never be satisfied with a single diagnosis of tonsillitis or measles or what-not in the presence of pronounced abdominal symptoms, otherwise appendicitis is going to be overlooked occasionally.

Table I gives the important details in connection with the six cases which terminated fatally.

### CONCLUSIONS

(1) Appendicitis in early life is on the increase.

(2) Early recognition and prompt surgical treatment of appendicitis give almost uniformly good results, even in infants and the younger group of children.

(3) Delay in the recognition of the disease, or in instituting surgical treatment, accounts for the high mortality and the distressing morbidity in young subjects. Purgation and procrastination are responsible for most of the bad results.

(4) There appears to be a definite relationship between appendicitis and acute intussusception, and between hernia and appendicitis.

# MALIGNANCIES OF THE COLON*

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AND

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In 1922, in the *New York Medical Journal and Record,* in association with Dr. R. F. Carter, I reported 129 cases of malignancy of the colon coming under my operative observation in a period of six years preceding the report.

At this time I am reporting an additional 186 operated cases from January, 1921, to January, 1928, a period of seven years. Out of the first series of 129 there were fifteen inoperable, while out of this series of 186 but eleven were recorded as exploration only, showing one of two facts: either that we were obtaining our cases earlier, or we considered and found the operability better as we were becoming more adept and more proficient in our judgment. I am privately inclined to the latter view. Patients whom I would not have accepted earlier in my career, I am operating lately with a very fair outlook.

Malignancies of the large intestines far exceed that of the stomach, while the small intestine has been found with a malignancy in but one instance by me in over five years. This one instance occurred in the past year: the site of the growth just distal to the ligament of Tritz. The sites of the growth in this series vary slightly from those reported in the recorded 129 cases.

Taking the two series together, the frequency record as to position is 103 rectum and recto-sigmoid, 105 sigmoid proper, fifty-one cæcum and ascending colon, thirty-five terminal transverse colon, splenic and descending colon, twenty-one terminal ascending colon, hepatic and proximal transverse colon.

The age and sex of these patients were rather equally divided in patients with the growth above the sigmoid. A marked difference in sex preponderance occurs in females in the lowest segment, the recto-anal. In the sigmoid, in a series observed, there were ten more males than females, while in the recto-sigmoid and the recto-anal there were ten more females than males. The average in the 129 observations was forty-nine years, the youngest a female of twenty-two, the oldest a female of eighty-nine.

The rapidity of growth in these patients is influenced as is cancer in other parts of the body; *i.e.,* by the age of the patient and the type of cell. The structures invaded primarily are mucous membrane, musculature, etc. The more youthful the patient the more rapid the growth. The lapse of time

between the initial onset of the growth and the time of operation cannot be estimated, as all calculations must be based upon and reckoned from the appearance of the first symptoms, either subjective or objective; and unfortunately, often the first symptom is objective, such as blood or mucus in the stool. Multiple growths have not been encountered in this series, neither was there one in the series reported in 1922, although I have seen multiple growths in cases considered in earlier contributions.

An interesting instance occurred in the series reported in 1922 that may be considered a multiple growth, or again may be classed as a remote-appearing secondary growth. This patient had had a typical Friedreich operation by me for a cæcal and appendicular carcinoma three years before, followed in two and one-third years by a growth in the sigmoid. It may well be speculated that this patient had the sigmoid growth at the time of resecting the cæcum, etc., or that he had a metastasis (unusual) in the sigmoid from the growth removed. This patient had had an exploratory appendix operation done one year before I saw him, and his appendix, for some unknown reason, was not removed.

From the viewpoint of regional classifications, the symptoms should vary somewhat, but in the main they are prone to slight variation. It is a well-observed fact that in growths involving the cæcum and ileo-cæcal regions obstruction is a rarity, due to the liquid state of the contents of the small bowel. No acute ileus was observed in any of the patients in this series, but in several instances definite cramp colics were located in the right lower quadrant, showing in these patients upon operation a very small opening at the ileo-cæcal valve, due to growth invasion almost closing the valve opening. There is an ever-present anæmia in these patients, characterized by a very profound state in the majority of cæcal and ascending colonics, gradual improvement in hæmoglobin as the growth is found toward the recto-sigmoid; in other words, the higher (more proximal) in the colon the growth is, the more profound the anæmia will show.

Palpation evidence in the cæcal and ascending colonic growths is apt to be late, as is also X-ray evidence, while in the sigmoid zone X-ray is prone to show earlier evidence. This is due to the presence of annular growths in the sigmoid as compared to lateral or mural growths in the cæcum, also to the calibre of the gut in these areas, as well as to the musculature structure.

Some of these patients complain of a feeling of soreness and distress with pressure at the site of the cæcum and appendix, particularly so when the growth becomes obstructive. On various occasions I have operated for these growths when the patients have been previously operated for a so-called chronic appendix. I plead guilty to the same operative error on two occasions. Our error is easily explained, recalling that an obstruction, either partial or complete, exists distal to the cæcum, that the small intestine is pouring fluid contents into the cæcum with the by-product of gas due to fermentation, etc., and that the egress is obstructed. The resulting dilatation of the cæcum, appendix and upper colon becomes a source of pain or distress,

and unless great care is observed by the eye and palpating fingers, the true source of the symptom is overlooked.

My first offense, about twenty-five years ago, was in a young man of thirty-four with a colloid carcinoma of the transverse colon. I removed the appendix (for pain in the right lower quadrant) that contained foreign bodies, was eight inches long and one-half inch in diameter in the greater portion of its length; cæcum not dilated enough to call attention to the importance of further search; followed in ten days by total obstruction, which I thought at this time to be an ordinary surgical complicating sequence, as obstruction by adhesions, bands, etc. Upon opening the abdomen the growth was found in the mid-transverse colon. Recovery followed proper repair, the patient living eleven years, and dying of a large growth of the right shoulder, X-rayed as an osteo-sarcoma, no biopsy or autopsy being done.

The second of my own was in a patient who bled from his bowel about six weeks after his discharge from the hospital for an appendectomy. X-ray on this patient before operation was reported negative. Subsequent to his bleeding, X-ray reported growth in the splenic flexure.

I am not inclined to lay great stress on alternating diarrhœa and constipation, as by the time these occur the diagnosis by other and earlier symptoms should have been made.

Colic in the cæcal area is in evidence whenever the growth is sufficiently occlusive to obstruct free flow through the ileo-cæcal valve, or through the caput into the colon. As the disease progresses, when located in the distal colon, cramp and colics are in evidence in the direct relationship to the amount of obstruction in existence. This symptom is essentially not due only to the invasion of the gut but to the consistency of the contents. The contents becoming more and more firm, as the terminal colon is reached it is quite evident that the mass becomes more obstructive, and that a calibre in the upper colon would transmit much that, due to absorption of fluids as it migrates to the distal colon, would readily obstruct the same calibre in the distal colon. It is therefore safe to state that the more liquid the colon content the less appearance of colics; and the reverse, that the more solid the moving mass the more evidence of colics and the earlier the obstruction.

Early toxemias are more often seen in obstructions of the proximal portion of the large bowel than in the distal half, easily explained by bacterial growth and absorption of toxins by the small intestines, and by the cæcal sewer trap one sees in practically all of this type. Borborygmus may be present or absent; if present, it is likely to be of a metallic, hissing sound like that due to gas or fluid passing through a small calibre. In obstruction, partial or complete, I have called attention for years to a metallic tinkle heard with the ear over the cæcal region when the opposite side is sharply pushed towards the median line. This sound is due to the collection of fluid contents in the cæcum with gas above it. I consider this sign an infallible one. In the post-operative obstructions one hears this same sign, also in the small intestines, and it is just as infallible. The conveyance of the heart sound in ordinary obstruction is not as a rule so evident in these cases unless the obstruction is of long duration. When this sign

(the metallic tinkle) is evident, operation should not be delayed. Fortunately for all, obstruction of the large intestine is never accompanied by the profound and grave toxic manifestations seen in obstruction of the smaller intestines.

The pains observed in these patients, excluding those of colics and spasms, in the sciatic, the lower back perineum, etc., are due to nerve involvements and pressure upon contiguous bones by growths involving the lower sigmoid, the recto-sigmoid and the recto-anal.

Pains in the lower back, sense of unfinished defecation, tenesmus, all demand an examination for growth in the lower sigmoid and rectum. It is rare to have these in high sigmoid involvement. Blood and mucus in the stools, frequent trips to the toilet, loss of ambition, loss of weight, pallor, etc., are added symptoms and signs of great weight. In the sphincteric area and just above it we may have a sphincter failure, due to infiltration of the muscle preventing the action.

The occurrence of perforation is not to be underrated, but when there is a sharp pain in the left lower quadrant without emaciation, without anæmia, no history of bloody or mucus stools, a patient robust, squattily built and about forty-five to fifty-five, diverticulitis should demand the first attention. I have seen about ten perforations in the 315 cases, all being found in sigmoid growths. Three were in the 129 series and the balance in the added 186.

*Aids in Diagnosis.*—Aids in diagnosis that are of inestimable value are the proctoscope and the X-ray. No patient who has pain in the lower back, perineal or sciatic distribution, who complains of distressing flatulence, tenesmus, or blood or mucus in the stool, should be allowed to leave the physician's observation before proctoscopic examination is made. No patient with abdominal colics, a sense of distress at any of the colonic flexures or throughout its course, nor in the event of a slow losing of weight, with or without evidence in the feces, should be dismissed from observation until a careful series of X-ray plates is taken. These should be taken both from a barium or bismuth intake by mouth and by enema. When one suspects a malignancy or other variety of obstruction impending, it is advisable to take the X-ray first by means of enema. On two occasions recently we have seen acute obstruction instituted by the intake by mouth, due to the mass forming, rocklike in character of the barium, causing a plug at the contracted lumen, necessitating thereby an emergency operation.

I am disinclined to give radium and X-ray any consideration except in the positively inoperable variety, as my experience with these agents is not pleasing in these growths.

Surgery, as early as one can, will give as good results in the colon as elsewhere. Late surgery is an alleviating agent in the majority. As previously stated, in the 315 patients but twenty-six were rejected as inoperable in some way or other: *i.e.,* even no artificial opening was advisable.

*Pre-operative Treatment.*—Thorough intestinal cleaning should be done when possible by cathartics, intestinal antiseptics and colonic irrigations;

when not possible, and this type is in the majority, an artificial opening should be made, thorough cleansing by irrigations for a week or ten days before the radical operation is done.

The artificial anus site is a matter of choice to the operator, but for years my selection has been the cæcum in preference to the other segments of the colon, because in all growths distal to the cæcum this position of the artificial anus is remote from the field of the final operation and does not interfere by newly-formed adhesions nor by soiling; and, finally, it is easy to close after its function has been terminated. The cleansing of the distal bowel through a cecostomy is readily performed by irrigation after the cecostomy is old enough—two to four days—to prevent leakage into the peritoneal cavity. It is gratifying to observe with what facility the rectal tube can be introduced into the colon through the cecostomy wound during the period of irrigation. A reverse peristalsis takes place readily during this period. During the time of the functionating artificial anus and before the radical operation is performed, careful attention must be given to renal functioning and nutrition. When possible, a Paul's tube is used for the first few days, such a procedure prevents the profuse liquid soiling that occurs in the early days if a Paul's tube is not used; an irrigation may then be carried out before the patient leaves the operating table.

*Radical Procedures.*—Under the heading of radical procedure one must consider the formation of a permanent artificial anus and the removal of the growth, with repair of the divided ends of the gut. Artificial anus as a temporary expedient has already been discussed, but as a permanent objective several important pathological features must be considered. A permanent artificial anus is to be made only in those patients in whom we find the growth so firmly fixed to surrounding structures that removal would end disastrously, or in patients in whom the contiguous and remote metastases are so extensive as to predicate an early demise with or without operative procedure. In this latter type with remote metastases, as in the liver, I have been doing the radical resection with anastamosis because a permanent artificial anus does not cause the metastases to subside, and because patients with an artificial anus in this variety of pathology, living for a period of from a few months to the best part of from two to three years with all the disagreeable associations of an artificial anus, could have had all the discomforts allayed or abolished by an additional risk of a small percentage. I have been very pleased with the results in this type of operation during the past ten or twelve years.

In the permanent artificial anus patients two methods of procedure as to the growth are to be followed. In the first instance the growth is allowed to remain, while in the second the growth is removed with all the surrounding tissue. The growth is left in those cases in which we find the infiltration extending beyond the possibility of total removal. Therefore, rather than excite a mushroom activity, the distal segment, after the proper preparation, is dropped into the abdomen and the proximal end is sewed into the abdom-

inal wall; or as in the lower sigmoid growths, one may leave the double-barrelled anus so that radium may be applied directly from above and below through the upper and lower stomas of the bowel. In the event that the growth is removable (this applies, of course, to the lowest segment), the lower portion is liberated from the sacral groove; then a perineal approach is made to remove this portion, the whole segment with the growth being delivered through the perineal incision.

In the event of a non-removable growth in portions of the colon proximal to the sigmoidorectal zone, short circuiting by means of a colonic or ileal byway is in order. This prevents an early total obstruction or a series of periods of partial obstruction.

*Methods of Anastomosis.*—As to the question of the method of anastomosis, end-to-end, side-to-side, or end-to-side, by suture or mechanical appliance, one must judge his own capacity for the type he will select. The advance in ability to suture without leakage in the great majority of instances, the ability to do fairly rapid work, and the improved qualities of catgut now upon the market place the Murphy button in the discard.

I have been doing the majority of my anastomoses during the past few years by the end-to-end method, doing a plastic on the smaller calibre end to meet with the larger end, as in the Friedreich operation, except in those instances where the gut is friable from œdema. In these a side-to-side is as a rule successful. Nor do I fear the hypothetical pocketing in doing a side-to-side anastomosis, because I always make the opening extend to within one-half inch of the inverted ends. I have had no more leakages in my end-to-end anastomoses than in the side-to-side, or end-to-side. Of course, there are occasions where one feels that a few minutes saved by doing a side-to-side will be advantageous.

For the past few years I am inclined in the recto-sigmoid operations to the making of a permanent sigmoidostomy and either resecting the lower gut or turning in the lower stump after one of the many excellent methods in vogue. The Coffee, and allied operations, are readily performed with very satisfactory outlook.

The operation of Mikulicz is quite applicable to the growths from the cæcum to the lower sigmoid and, while its hospital time is longer by 25 per cent. to 33 per cent., the mortality is so much less that one should practice this type more in the sigmoid bowel than any other type of operation. End-to-end anastomosis is a safe procedure from the cæcum to the mid-transverse colon, leakage being less, but when one approaches that portion of the gut with a wide base to its mesentery attachments, either the side-to-side or the Mikulicz operation should be done. Side-to-side operations, or end-to-side, are rarely accompanied by pouching and retention if the anastomosis is so made that a pouch does not exist at the time of operation.

Operation on the lower segment is readily done through the perineum, with or without removal of the coccyx. One can readily pull down, by careful dissection, six to twelve inches and implant the cut end in the per-

ineum either in the fore or rear part. I am inclined to give this operation first place in all lower growths.

The absence of early secondaries, in the low rectal and anal types, is readily explained by the lymphatic distribution. I am also struck by the good control many of the patients have.

The extensive operation of Miles I cannot, at present, feel is called for, particularly after closely analyzing his immediate and remote mortality.

It is customary to have an artificial anus established for seven to fifteen days before doing the radical operation. This procedure is the cause of the disappearance of the toxemia existing at the time the patient first comes under observation and permits of cleansing the bowel to the site of the growth, thereby facilitating the resection and preventing infection, to a great degree. It also brings about the subsidence of the œdema often seen in the proximal portions, and the subsidence of the marked distention—thereby bringing about a more normal diameter of the proximal end for anastomosis with the distal end. Finally, it is a safety vent during the repair of the suture line of anastomosis by preventing distension with gas and feces, and by taking the weight of the column of feces from the site of anastomosis again prevents leakage to a great degree.

A very excellent device for anastomosis by the end-to-end method in the lower segment is the Balfour tube method, with invagination of the anastomosis ring; this tube acting as a byway for both gas and feces.

I am not strongly inclined to believe that a complete circle of peritoneum is necessary for prompt union, though admitting its usefulness in promoting repair, but believe that in anastomosing, say the sigmoidorectal zone or sigmoid, that the first essentials are the preservation of the muscular and mucous membrane circulation, the exclusion of all fat lobules, and the accurate approximation of the muscular and mucous coats.

Admitted that anastomosis in these zones is particularly prone to fecal fistula formation, then the most important step is the instituting of proper and competent drainage for a few days. In the anastomosis proximal to the sigmoidorectal zone, I prefer no drain except in the skin wound.

### END RESULTS

1. Extension of life with no foul discomforts; in those patients with existing metastasis in the liver at the time of operation, from eight to twenty-four months or more.

2. In those in whom no appreciable metastases at remote zones are found, extension of life from months to years. In this series we have traced the greater number of patients and find that there are several of each variety living from one to twelve years.

A great deal of lowering of the mortality in the past years is due, I feel, to the preliminary drainage by means of an artificial opening, and the care observed in placing this opening remote from the field of expected removal. This latter prevents undue adhesion work and soiling of the area by handling

of an artificial anus when made in or close to the segment of gut to be excised. A goodly portion of the high mortality has also been due to the desperate condition in which some of the patients came to us, as several died following the performance of an artificial anus even under local or gas anæsthesia. This increase in mortality was due to the toxemia from obstruction absorption.

### RADIUM AND X-RAY TREATMENT

I do not feel entitled to discuss this treatment, but have some very definite views as to their general inefficiency as a cure. The question of pre-operative "sickening" the cell growth in patients when the growth can be reached is one of weight, well worth considering, although so far, I cannot speak with the same fervor as do some of my confreres. Radium has its place at present in the treatment of growths in the rectum, but has again been rather disappointing to me in several instances of supposed cures, which relighted in from six to nine months with redoubled vigor, rapidly placing the patients beyond operative relief, while in the majority of patients its service has not only been negligible but, I am satisfied, deleterious.

# MORTALITY FOLLOWING COLOSTOMY FOR CARCINOMA OF THE LARGE BOWEL

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FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

The type of operative manœuvre used in accomplishing colostomy varies somewhat according to the personal inclination of the operator, but certain measures, proved essential by experience, establish the advantages of one or
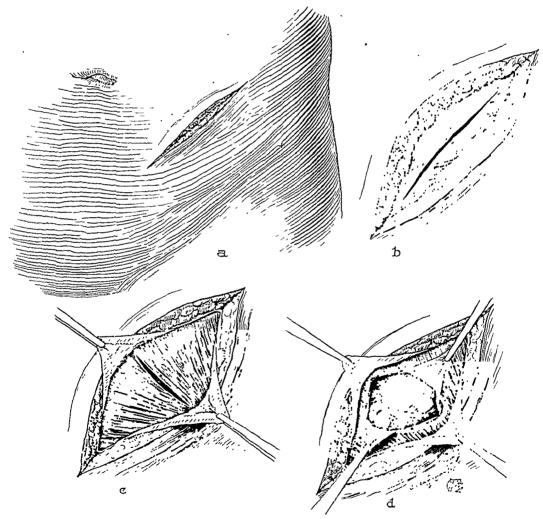


FIG. 1.—Split-muscle incision in the left lower quadrant of the abdomen, exposing the sigmoid. The incision bisects, at right angles, a line drawn from the umbilicus to the anterior-superior spine.

two procedures. In performing colostomy, either as a palliative or first-stage procedure, it is fundamental that the liver, regional lymph-nodes, and neoplasm be thoroughly explored in order to determine the advisability of secondary operation. This may or may not necessitate an accessory incision,

some operators preferring a low median-line incision when dealing with rectal and rectosigmoidal growths, exploring through it and using a smaller inguinal incision for the performance of the colostomy. I prefer to make a split-muscle incision well toward the anterior-superior spine of the ilium, through which adequate exploration may be carried out. The right rectus type of colostomy has its advocates and unquestionably is satisfactory in many instances, but it has two outstanding disadvantages. In most cases one will find herniation or at least weakness of the abdominal wall around the stoma, since closure around the bowel must of necessity be loose, and occasionally the loop of the colon may become an axis around which the small bowel revolves to become obstructed. A split-muscle incision and a Maydl type of colostomy, with certain modifications, approaches the ideal operation and, except when the mesentery of the descending colon or sigmoid is very short or absent, may be universally adopted. If the mesentery is not adequate, colostomy can be performed only in the transverse colon, a procedure which always necessitates a separate incision.
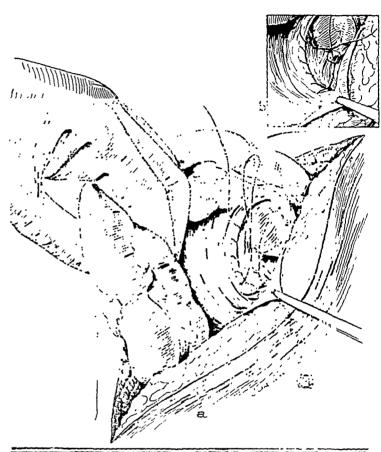


Fig. 2.—After exploration the sigmoid is "fed" back into the abdomen until its most fixed portion close to its juncture with the descending colon is reached. Here there is generally a fold of peritoneum running off from the lateral parietal peritoneum to the mesentery of the bowel. A purse-string suture placed around this obliterates the foramen laterally to the bowel and prevents obstruction from the loop of the small bowel slipping through it.

Sometimes there is controversy as to what portion of the bowel should be selected for permanent colostomy and while it is usually agreed that the sigmoid flexure is the most advantageous point, provided it has a long mesentery, occasionally the transverse colon is advocated. I have found that this portion of the bowel is not so satisfactorily employed and I avoid using it except in cases in which anatomic abnormalities render it necessary. Permanent colostomy in the transverse colon to precede resection leaves a long blind pouch of colon which fills up with fecal material despite the most enthusiastic measures for washing it out, and resulting discomfort is the rule rather than the exception. When the transverse colon is selected a mucous

fistula in the posterior sacral region is desifable so that through-and-through irrigation may obviate the accretion of fecal material.

Three suggestions are of practical value in performing colostomy. First, the opening should be made as high as possible in the sigmoid or descending colon. By feeding the colon back into the abdomen as it is brought into the incision, one comes to a semi-fixed point where the bowel may be approximated in the wound yet not pinched tightly with the margins of the incision. This prevents herniation of the mucous membrane of the proximal loop months after the stoma has been cut through and the patient has become accustomed to it. Second, a section of skin, several centimetres wide, should separate the two ends of bowel after it has been divided. This prevents the passage of fecal material into the distal loop as it may in the event that a blind pouch from 5 to 10 cm. long is left below after secondary resection. Third, the small space between the mesentery of the bowel and the lateral parietal peritoneum should be obliterated. As one pulls up the colon a peritoneal band extending from the lateral parietal peritoneum onto the mesentery of the sigmoid is usually



Fig. 3.—a, Hole made in mesosigmoid; b, rubber tube in place.

found. If a purse-string suture is run around this band, including the parietal peritoneum as far as the anterior abdominal wall, and onto the mesentery, obliteration is accomplished and there is no danger that the small bowel will slip through the foramen and become obstructed. This has happened in an occasional case when this precaution was not observed. Except when the mesentery is heavy with fat and bleeding is difficult to control, or when the mesentery is extremely short, such a technical procedure is simple and easy. The abdominal wound is closed loosely around the bowel, only a few interrupted sutures being placed on the aponeurosis of the external oblique muscle. I believe it is important that the two layers of the abdominal wall, peritoneum and skin, be brought together and sutured under the bowel through a rent in the mesentery.

Fecal control following colostomy has been the object of ingenious procedures directed toward the manufacture of a sphincter muscle, which often result satisfactorily. The fact that practically any type of stoma may be

attended to easily so long as the bowels are constipated, renders the results of colostomy satisfactory in the majority of cases. Control becomes partial in about three-fourths of the cases and by cleaning the stoma and irrigating it once or, at most, twice a day, habits are formed which soon lose their onerous nature. A technical manœuvre of C. H. Mayo's has been used in the Mayo Clinic for the last year with eminently satisfactory results, so far as control is concerned. He transplants a strip of the internal oblique and transversalis muscles around the upper loop of the bowel which is to be included in the colostomy, throwing this flap from below upward, leaving the piece attached to the outer side and bringing a similar skin flap from above
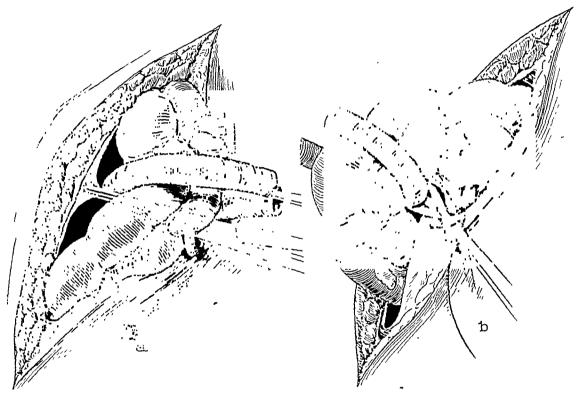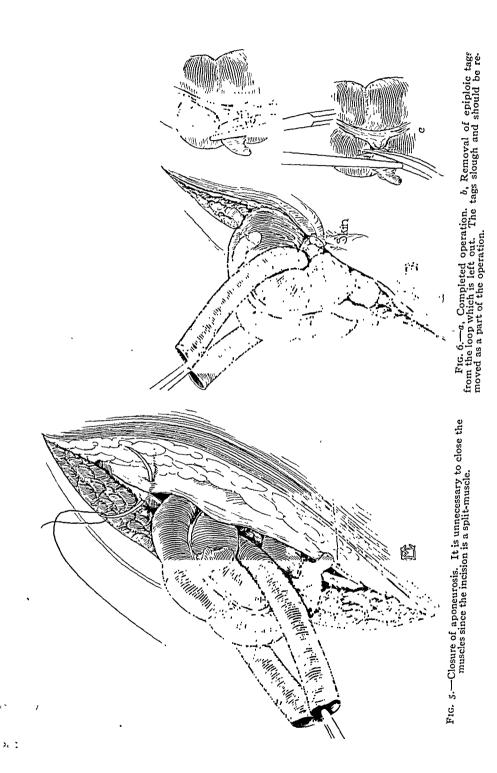


FIG. 4.—*a*, Peritoneum pulled under the sigmoid loop and sutured. With the exception of the skin, this is the only part of the abdominal wall necessary to pull under the colostomy. The opening in the mesentery is just in front of the purse-string suture which obliterates the lateral foramen. The peritoneum at the middle of the incision is pulled under the bowel. *b*, Skin pulled through and sutured in a similar manner to the peritoneum.

downward, which covers the bowel from behind, and over which slight pressure may be applied by a simple apparatus to prevent leakage of fæces.

Colostomy, whether performed preliminary to subsequent resection or as a palliative procedure for obstruction in cases of inoperable malignant growth is customarily not regarded as serious since the mortality rate is not excessively high. This is justified in cases in which the risk is not great because the colostomy is preliminary to resection. The death rate was not high in a large series of cases in which primary colostomy was performed for drainage followed by removal of the offending lesion. However, the mortality rate was high in a series of cases of carcinoma of the large bowel in which colostomy had been a palliative measure. Unfortunately in this group were a relatively large number of patients having malignant tumors of the colon who presented themselves for examination and treatment. In a few

FIG. 6.—*a*, Completed operation. *b*, Removal of epiploic tags from the loop which is left out. The tags slough and should be removed as a part of the operation.

FIG. 5.—Closure of aponeurosis. It is unnecessary to close the muscles since the incision is a split-muscle.

cases faulty technic or an accident in the operating room might have been the cause of peritonitis but usually contamination from the growth itself, spread by the simple manipulation necessary to ascertain the degree of fixation and involvement of the lymphatics and operability was the underlying reason. The cause of death in the group of cases in which palliative resection was performed is not far to seek, since most of these patients appear for treatment in the latter stages of the disease when obstruction, desiccation and anæmia have undermined their vitality, so that a slight infection may gain headway rapidly and t e r m i n a t e fatally. The performance of colostomy and exploration under such circumstances b e c o m e s hazardous. Obstruction m u s t be relieved, and in many instances it is this unavoidable operation which increases the mortality rate in the entire group in which colostomy is performed.

Deaths and f a c t o r s which cause death following colostomy should be classified according to the two main groups of cases in which this occurred: First, those in which colostomy was performed and in which the condition prohibited continuance of the operation, and, s e c o n d, those in which resection was to follow colostomy
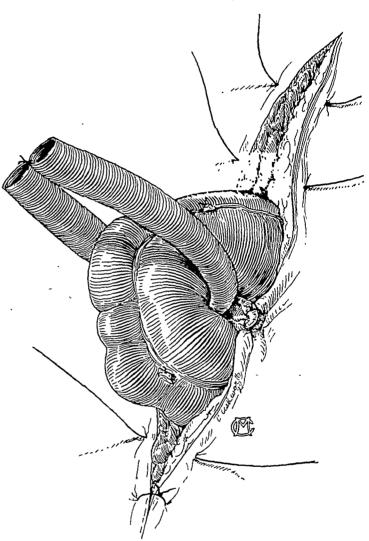


FIG. 7.—Closure of skin and completed operation.

but death supervened before the second stage could be carried out. In order to arrive at some conclusions relative to the causal factors and percentage of mortality in a large series of cases, I have reviewed the records of 919 cases in which colostomy has been performed in the Mayo Clinic from 1920 to 1926, inclusive. Colostomy was performed in 385 cases in which further procedures were deemed impossible because of metastasis, extensive local involvement, or other factors which made it impossible to eradicate the malignant growth. In 584 cases, at exploration for colostomy, the growth was deemed resectable; however, in sixteen cases death occurred before the operation could be completed. From these figures it will be seen that a mortality of 7.67 per cent. attends the performance of colostomy as a pallia-

tive measure and 2.7 per cent. is the mortality rate of the operation in the group in which further operation is considered advisable.

In the first group of 335 there were 246 males who ranged in age from eighteen to seventy-seven years, the average being fifty-five years, and eighty-

TABLE I.

*Age and Sex Incidence by·Decades in 335 Cases in Which Resection was Impossible Following Colostomy*

| Age | Males | Per cent. | Females | Per cent. | Total. | Per cent. |
|---|---|---|---|---|---|---|
| 10–19 | 2 | 0.81 | | | 2 | 0.59 |
| 20–29 | 7 | 2.84 | 6 | 6.75 | 13 | 3.88 |
| 30–39 | 15 | 6.09 | 9 | 10.11 | 24 | 7.16 |
| 40–49 | 43 | 17.48 | 21 | 23.60 | 64 | 19.10 |
| 50–59 | 72 | 29.26 | 32 | 35.95 | 104 | 31.04 |
| 60–69 | 84 | 34.14 | 14 | 15.73 | 98 | 29.25 |
| 70–79 | 23 | 9.34 | 7 | 7.86 | 30 | 8.95 |
| Total.... | 246 | | 89 | | 335 | |

TABLE II.

*Conditions Prohibiting Resection Following Colostomy in Group of 335 Cases, with Number of Deaths in Hospital*

| | Cases | Hospital mortality | Per cent. |
|---|---|---|---|
| Metastasis to liver................................ | 100 | 2 | 2 |
| Fixed and extensive growth (obstruction in thirty) ......... | 140 | 17 | 12.05 |
| Acute obstruction.................................... | 7 | 3 | 42.85 |
| Attachment to bladder and peritoneum................... | 21 | 2 | 9.52 |
| Peritoneal and retroperitoneal involvement.............. | 17 | | |
| Pelvic metastasis..................................... | 9 | 1 | 11.11 |
| Involvement of bladder................................ | 8 | | |
| Involvement of prostate and bladder..................... | 6 | | |
| Attachment to prostate................................ | 3 | | |
| Metastasis to inguinal lymph-nodes .................... | 7 | | |
| Metastasis to mesentery............................... | 4 | | |
| Multiple intestinal metastasis.......................... | 6 | 1 | 16.66 |
| Poor general condition (age, secondary anemia)........... | 6 | | |
| Epithelioma of larynx................................. | 1 | | |
| Total......................................... | 335 | 26 | 7.76 |

nine females, who ranged from twenty-two to seventy-three years, the average being fifty-four years. Table I shows the age of patients by decades. It is interesting to note that death in hospital occurrs in certain groups of cases consistently and that fixation and obstruction are predominant factors in cases in which death supervenes. The various conditions contra-indicating

TABLE III.

*Cause of Death in Twenty-Six Cases in Which Death Followed Palliative Colostomy*

| Cause of death | Cases |
|---|---|
| General peritonitis | 14 |
| Bronchopneumonia | 5 |
| Acute diffuse nephritis | 3 |
| Pulmonary embolism | 1 |
| Œdema of lungs | 1 |
| Perirectal and perirenal abscess with general sepsis | 1 |
| Cerebral hæmorrhage or embolus (?) and myocardial degeneration | 1 |

resection are tabulated in Table II. It will be noted that in 100 cases secondary resection was refused because of metastasis to the liver; however, this condition apparently did not increase the immediate mortality since only two of these patients died. Fixation and extension of the growth to adjacent vital structures rendered resection impossible in 140 cases; death occurred

TABLE IV.

*Cause of Death in Sixteen Cases in Which Colostomy was Performed Preliminary to Resection*

| Cause of death | Cases |
|---|---|
| General peritonitis | 10 |
| Pulmonary embolism | 2 |
| Bronchopneumonia | 2 |
| Pneumonia | 1 |
| Empyema | 1 |

in seventeen of these. The highest mortality was associated with acute obstruction, nearly half of these patients dying following the primary operation. Peritoneal, vesical and prostatic involvement was common, but apparently did not add particularly to the operative mortality. Multiple intestinal metastasis occurred in six cases with death in one, and metastasis to the mesenteric and inguinal lymphatics was noted in eleven cases, in which there were no operative deaths. In only six cases was resection considered

inadvisable because of age, secondary anæmia, or general debility. The causes of death in the twenty-six cases which terminated fatally in the group in which palliative colostomy was performed are shown in Table III. Peritoneal contamination and pulmonary complications account for practically all, more than half being due to peritonitis. Pulmonary embolism was present in one case. Death followed colostomy in sixteen cases of the group deemed suitable for resection and the cause of death in these cases is given in Table IV. Peritonitis accounted for ten deaths, while pulmonary complications were responsible for the other six, pulmonary embolism being the cause of death in two cases. It is interesting to compare the mortality figures in the two groups from the standpoint of general resistance. Although the group for resection far outnumbered the group in which only palliative operation was performed, the mortality figures were reversed, two and a half times as many patients in the latter group dying after exploration and colostomy as in the former. Unquestionably the growths which cause obstruction and which are manipulated at exploration are the source of most peritoneal contaminations; for this reason the abdomen should be explored before the growth itself is handled. Further proof that the growth is the source of infection in many instances lies in the fact that in a graded operation on the colon or sigmoid, fatal peritonitis may result when there is no leakage at the line of anastomosis and resection at the second stage has been accomplished with perfect asepsis. The permeability of the wall of the bowel when there is obstruction is largely responsible for the increased likelihood of contamination. To obviate increased permeability and prepare patients more satisfactorily for any operative procedure on the colon, coöperative management, which includes pre-operative and post-operative care under group consultation, unquestionably is one of the most important adjuncts. The adequate cleansing of the bowel before operation, and the institution of the proper measures for rehabilitation of the patient before and after operation, have contributed materially to satisfactory end results.

# THE CARE OF THE COLOSTOMY

By George E. Binkley, M.B. (Tor.)

of New York City

FROM THE MEMORIAL HOSPITAL

A colostomy is always an inconvenience and when not given adequate attention it becomes a nuisance. The principal annoyance of the neglected colostomy is not only endured by the patient himself, but is extended to all persons with whom he may associate. However, despite certain adverse conditions associated with colostomies, they are essential, and at times imperative.

The foremost inconveniences of the colostomy have not been lessened, either by numerous attempts to construct an opening that could be voluntarily controlled by the patient, or by the mechanical appliances which have been invented for the same purpose. Nevertheless, the situation is not hopeless. There is a means of controlling these involuntary artificial ani, so that the patient may enjoy a comparatively comfortable life.

The colostomy bag, a popular appliance for involuntary control, is uncomfortable and difficult to keep clean and odorless. Although this apparatus provides for the collection of feces, it does not prevent contamination of the clothing by offensive odors; furthermore, constant wearing of these bags often produces a protrusion of the bowel and a weakening of the abdominal muscles.
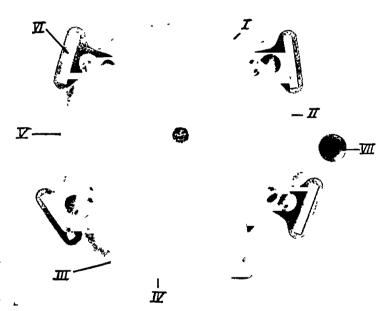
Fig. 1.—Exterior surface of cup. I—Convex surface of bowl of cup. II—Flat rim of cup. III—Outlet projection arm. IV—Shoulder on projection arm. V—Circular opening in centre of cup. VI—Belt clips attached to rim. VII—Threaded plug.

Although an involuntary anus naturally requires more detailed care than the normal anus, nevertheless this fact is commonly disregarded. The most satisfactory condition is created by daily evacuation and lavage of the colon by means of a colonic irrigation. Clinical experience has proven that an irrigation of this nature prevents the expulsion of feces and escape of offensive odors for a period of twenty-four to forty-eight hours, thereby allowing the patient to carry on his ordinary routine as an inoffensive member of society. Usually the cleansing of the colon is completed in the morning (by the aid of tap-water, saline, or a weak solution of permanganate of
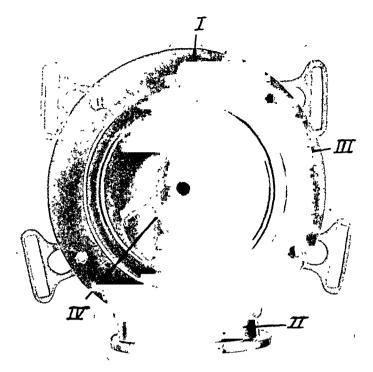
FIG. 2.—Interior surface of cup. I—Concavity of cup. II—Outlet of cup. III—Groove of rim. IV—Circular opening in centre of bowl.



FIG. 3.—I—Canvas belt. II—Long rubber tube for bedridden patients. III—Short rubber tube for ambulatory patients. IV—Rubber bag for residual fluid. V—Small catheter.

potash). A mild saline cathartic before breakfast is advantageous in producing a quick result with a constipated patient. Formerly the paraphernalia used consisted of the ordinary irrigating can, a few feet of rubber tubing, a stop-cock and a medium sized catheter. The latter was inserted into the colon for a distance of a few inches and the fluid allowed to flow until a feeling of fulness was produced. The flow was then stopped, and the catheter withdrawn, and the contents of the colon allowed to discharge into a receptacle. These steps were repeated until a copious evacuation and a thorough cleansing were obtained.

The results of this open method of irrigation were excellent. The operation itself, however, was frequently accompanied by unpleasantness and in



A – Bowl of Cup.
B – Inflow catheter.
C – Soft rubber tube attached to the outflow arm.
D – Colon
E – Abdominal wall.
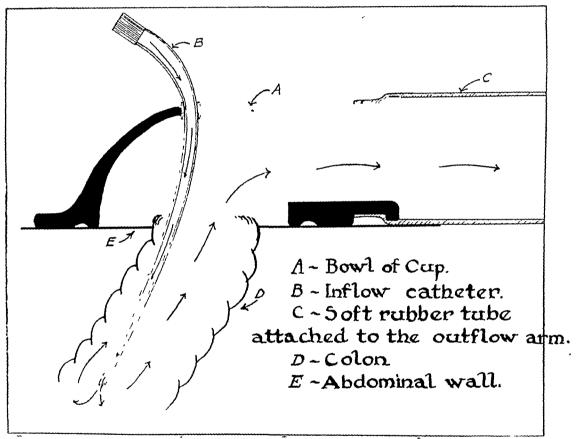
FIG. 4.—Cross-section drawing of cup in position.

many instances a certain amount of soiling could not be prevented. These difficulties were always enhanced when the patient had insufficient assistance and improper facilities. The difficulties and accompanying embarrassment of the above procedure suggested to the author the possibility of the closed irrigating apparatus which overcomes the main obstacles and makes fecal evacuation through a colostomy a simple and satisfactory procedure.

*The Colostomy Irrigator.*—The main apparatus which is composed of bakelite consists of a shallow cup or bowl with a wide rim. It is fashioned similarly to the cup of the Delatour colostomy bag. In the centre of the base of the bowl is a small circular opening through which passes a No. 20 French catheter for the inflow of the irrigating fluid. On one side of the bowl there is a large opening formed by direct extension of the bowl itself into a neck-like projection or extension, the outlet for the return fluid.

On the external surface of this extension, there is a projection shoulder which holds in place the soft rubber tube that conveys the fecal fluid from the cup to the receptacle or the toilet. The flat undersurface of the rim of the cup which rests against the skin has as its innermost margin a shallow groove to act as a seal and prevent leakage On the outer surface of the rim are attached four belt clips to which in turn is attached an adjustable canvas belt, which holds the cup in position. By shifting these attachments, the direction of the outflow may be directed downward or laterally.

In addition to the bakelite cup the following accessories are included in the outfit (1) an adjustable canvas belt; (2) a No 20 French catheter; (3) an irrigating can, (4) four or five feet of connecting tubing; (5) a stop-cock and connecting rod, (6) two large soft rubber outflow tubes, one short and one long; (7) a short soft rubber bag—collecting bag for residual fluid; (8) a threaded plug, to close the opening in the centre of the cup. This list includes all the special apparatus necessary for cleansing the colon through a colostomy opening in bedridden or ambulatory patients.

### TECHNIQUE OF PROCEDURE

The irrigation of the colon is less difficult through a colostomy than through the rectum. The principles are the same in both instances, since the irrigating cup, together with the attached outflow tube, serves the same purpose as the return-flow rectal tube that is used in giving ordinary colon irrigations. The inflow catheter is inserted into the



Fig 5 —Apparatus in position, bedridden patient.

colon for a distance of three to six inches and is not withdrawn during the irrigation. The return flow is expelled into the cup and then passes through the outflow arm of the cup into the attached extension outflow tube which is of sufficient diameter to allow the passage of large fecal masses.

When the patient desires to take an irrigation, the stop-cock is closed, and the irrigating can, filled with warm water or a weak solution of permanganate of potash, is placed upon a stand a few feet above the colostomy. Before placing the cup in position, the inflow catheter is drawn through the

circular opening for the required distance, the desired direction of the out-flow is determined, and the belt and appropriate outflow tube are attached. In the case of bedridden patients, the flow is directed laterally, and carried by means of the long, soft rubber tube over the side of the bed into a receptacle, while the patient lies comfortably on his side or back. The ambulatory patient, however, directs the flow downward, uses the short rubber tube, and sits on the toilet.

The cup, more easily applied when standing or lying than when sitting, is placed over the colostomy. At the same time the catheter is inserted into the colon; the straps of the belt are then tightened so that the rim of the cup forms an air-tight con-nection with the abdom-inal wall. The rubber tubing leading from the irrigating can is connected to the end of the catheter protruding from the cup. The stop-cock is released and the fluid allowed to flow into the colon until the latter is partly filled or until a feeling of ful-ness is produced. The flow is then stopped by closing the stop-cock. The stimulated peristalsis pro-duced by the distension expels the colonic con-tents, which are conveyed into the toilet unseen by the patient. The proce-dure of filling the colon and allowing the contents to be expelled is repeated



FIG. 6.—Apparatus in position, ambulatory patient.

sufficiently often to insure the comfort of the patient for the succeeding twenty-four hours.

The time usually required for this procedure is twenty to thirty minutes. A small amount of fluid is occasionally retained within the colon for a few minutes after the principal flow is stopped. To prevent waiting for the expul-sion of this residual fluid, the attachments of the cup are changed as follows: The inflow catheter is withdrawn and the opening closed by a threaded plug; the outflow tube is removed and replaced by a short bag. The irrigating cup, while in position, is thereby converted into a temporary

colostomy bag. This apparatus is worn for one-half hour, when it is removed, cleaned and sterilized, and laid away for use the following morning. The only dressing required after the irrigation is a few layers of sterile gauze over the opening to absorb the small amounts of exuded mucus. This pad is usually held in place by adhesive straps or binder. Patients, especially those who are corpulent, are fitted with abdominal support, which adds to their comfort and prevents abdominal hernia about the artificial opening.

Our routine care of colostomies at Memorial Hospital may be summarized as follows: The bowel is opened by cautery or knife from two to four days after operation. The morning following, the patient receives a large dose of castor oil. Two days later we begin the daily colonic irrigations, and as soon as the strength of the patient will permit, he is carefully instructed in both the open and closed methods of irrigation; at this time he is provided with his own irrigating outfit and measured for an abdominal support.

The daily irrigation of colostomies has been in vogue for many years and experience has proven this procedure to be by far the most satisfactory method of taking care of these abnormal conditions. The closed method of irrigation was started two years ago and has proven so satisfactory that it is now employed routinely at the hospital.

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# CARCINOMA OF THE RECTUM AND RECTO-SIGMOID

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### of New York, N. Y.

A CLINICAL STUDY OF ONE HUNDRED AND SIXTY CASES, FROM THE SURGICAL DEPARTMENT
OF MT. SINAI HOSPITAL OF NEW YORK, SERVICE OF DR. A. A. BERG

This paper is based on a study of a series of one hundred and sixty consecutive cases of carcinoma of the rectum, seen at Mount Sinai Hospital on the service and in the private practice of Dr. A. A. Berg during the ten year period, 1916–1925, inclusive. The material will be presented according to the following outline: A. Operability. B. Treatment. C. Operative Procedures. D. Choice of Operation. E. Mortality. F. Ultimate Results.

Altogether in the ten year period, 1916–1925, there were observed on the Surgical Service of Dr. A. A. Berg at Mount Sinai Hospital, ninety-five cases of carcinoma of the rectum or recto-sigmoid. There were sixty-five additional cases among the private patients of Doctor Berg treated at Mount Sinai Hospital. Of this total of one hundred and sixty patients, nine left the hospital before studies were completed, and the one hundred and fifty-one remaining cases form the material for this study.

*A. Operability.*—The operability in cases of carcinoma of the rectum when seen by the surgeon has varied from 25 per cent. to 82 per cent. The following table shows the wide variation in the hands of different surgeons:

|  | Inoperable | Operable |
|---|---|---|
| Cripps[1] (445 cases) .............. | 75% | 25% |
| Back[2] ........................... | 70% | 30% |
| Gant[3] .......................... | 65% | 35% |
| Chalier and Perrin[4]............... |  | 20 to 50% |
| Lynch[5] (491 cases) .............. | 30% | 70% |
| Berg (151 cases) ................. | 16% | 84% |

Of the one hundred and fifty-one cases under consideration, twenty-four were considered inoperable, fifteen after exploration, nine without exploration. In these twenty-four inoperable cases, the following conditions were encountered:

| | | | |
|---|---|---|---|
| Local fixation to neighboring structures ................... | 6 times | Inguinal metastases ............. | 2 times |
| Bladder involvement ........... | 3 times | Other metastases .............. | 5 times |
| Vagino-rectal fistula .......... | 2 times | Ascites ....................... | 2 times |
| Urethro-rectal fistula ......... | 1 time | Cachexia ..................... | 2 times |
| Metastases in liver ........... | 6 times | Extreme old age ............. | 1 time |
| | | Myocarditis .................. | 1 time |

The conditions which bar radical operations are in general: (a) Local invasion of neighboring organs. (b) Distant metastasis. (c) Poor general condition.

(a) The neighboring structures which may be invaded are the uterus, vagina, adnexa, bladder, prostate, adherent small intestines, broad ligaments,

and the sacrum. Firm fixation of the tumor to these adjacent structures make the possibility of a permanent cure very unlikely. Mere inflammatory adhesions however do not necessarily interfere with radical removal of the tumor. The prostate or bladder in the male, and the uterus or vagina in the female, are not infrequently adherent to the growth. A hysterectomy may be included in the operative procedure when the growth is found to invade the uterus or adnexa. If bladder involvement can be determined prior to laparotomy, the case is considered inoperable due to the added operative risk of bladder resection, but if this complication should be met unforeseen at the operating table a bladder resection might be necessary. To avoid this possibility, cystoscopy should be performed whenever there are any bladder symptoms, and these should be carefully elicited while taking the history. Invasion of the sacral bone occurs but rarely, and the growth can usually be peeled from the sacrum.

(b) The presence of glandular or liver metastases must usually be left for discovery on the operating table. It should be remembered that enlarged glands in the groin are not always carcinomatous. These glands often prove to be inflammatory, and if so do not contra-indicate a radical removal of the tumor. Enlarged mesocolic glands on the other hand are more often carcinomatous, and any radical procedure must include their removal.

(c) Patients in poor general condition, or with deficient vital organs or complicating· diseases, are not capable of withstanding an extensive radical operative procedure. Severe cardiacs, consumptives, severe diabetics, nephritics, etc., come in this category.

In case of doubt as to operability, it is felt that the patient should be given the benefit of an attempt at radical cure by surgery. The outlook, otherwise, is hopeless. Radiotherapy has not effected cures. This attitude accounts for the extension of the limits of operability to 84 per cent. in this series.

Here as in all cancer problems, the early diagnosis is of importance. It has often been stated that tumors in this location are rather slow growing, and therefore can usually be discovered before they have spread if only the physician will make the search. In our twenty-four inoperable cases the duration of symptoms has ranged from two to eighteen months—averaging eight months.

The first symptom which appears may be bleeding, pain, increasing constipation, diarrhœa, or rectal discharge. Hemorrhoids may be concomitant—their presence does not preclude the presence of more important disease a little higher up. Several of our cases have had hemorrhoidectomies a few months before the discovery of the cancer.

Occasionally a tumor is accidentally found in the course of a routine examination with no symptoms referable to its presence. This is a strong argument in favor of regular periodic physical examinations. Whenever a patient presents himself to a physician with any of the symptoms enumerated above, the examination should include a thorough digital examination of the entire rectum, and also a proctoscopic examination with a suitable instrument.

Sigmoidoscopic examination and röntgenological examination by means of an opaque enema are used to locate lesions higher up than those which can be reached by the finger and proctoscope. In the high growths at the rectosigmoid junction especially in obese subjects, the tumor may be in a position where it cannot be palpated. Such a tumor may exist for months before ulceration will cause it to produce bleeding, pain or discharge, and may even go on to obstruction without having previously indicated its presence. A gas anæsthesia may be used if necessary to aid in determining by bimanual examination, the presence of a tumor, the approximate extent of gut involved, the amount of fixation, and the presence of intra-abdominal masses.

If a tumor mass is found, and there is doubt as to its nature—a biopsy should be performed through the proctoscope, and a Wassermann test always should be done. Lues, tuberculosis, papilloma and benign stricture are the conditions to be differentiated, and are all much rarer than carcinoma. With the diagnosis established, a search for metastatic foci is made. If bladder symptoms are present, cystoscopy is performed. A thorough general examination is made to discover complicating conditions.

*B. Treatment.*—We are offered three choices in treating a case of rectal carcinoma. (a) Palliative treatment (with or without colostomy). (b) Radiotherapy (radium and deep X-ray). (c) Radical operation.

(a) The ultimate result of palliative treatment is death accompanied by much suffering and misery. This choice obviously is only for those cases in which no hope of cure can be entertained. When for any of the reasons enumerated above a case is considered inoperable—this line of treatment must be followed. It consists in treating the pain and other symptoms as they arise, sometimes using radiotherapy as a palliative measure, and performing a colostomy when indicated.

An early colostomy is an advantage as the diversion of the fecal stream from the growth relieves the latter of irritation, lessens the diarrhœa and bleeding, and may lessen the rapidity of spread. The more thorough clearing of the bowels will relieve the intoxication of the patient. A colostomy done prophylactically prevents the necessity of performing it as an emergency after the onset of obstructive symptoms, when the general condition will be much worse and the healing powers at a low ebb.

Early colostomy requires the patient to live a colostomy life longer than is strictly necessary, but it is far from unbearable. Several inoperable patients have lived for many months in comparative comfort with a colostomy.

Cripps[1] compares two series of inoperable cases in only one of which colostomy was done.

| In 71 cases in which NO operation was done | In 97 cases in which COLOSTOMY was done |
|---|---|
| 33 lived less than 6 months | 10 lived less than 6 months |
| 31 lived 6 to 12 months | 11 lived 6 to 12 months |
| 7 lived 1 to 3 years | 62 lived 1 to 3 years |
| Average 7.8 months | Average 22.0 months |

In 21 cases with colostomy after obstruction had occurred 11 died following colostomy

In 130 cases with colostomy before obstruction had occurred 5 died following colostomy

(b) In our experience and in that of many other men, radiotherapy used alone has not resulted in radical cures. In the earlier days it was the cause of much suffering, tenesmus, diarrhœa and colitis. This has been lessened to some extent by improved methods of application and dosage, but is still far from ideal. Of what value pre-operative or post-operative radiotherapy for rectal carcinoma will prove to be we do not know yet. Radiotherapy may be useful as a palliative measure, but so far does not offer us much hope of permanent cures.[11]

(c) Therefore if radical surgical methods can present us with even a reasonable number of cured patients, we believe that it is worth while undergoing a considerable risk to attain that object. Furthermore we feel that even in the cases which have not been permanently cured, the removal of the rectal tumor by relieving the tenesmus, bleeding and other painful local manifestations, has succeeded in allowing these patients many months, or even years, of increased comfort.

*C. Operative Procedures.*—In this series 3 type operative procedures have been made use of: (a) Amputation by sacral approach (Kraske type). (b) Combined abdomino-sacral resection (with preservation of sphincters). (c) Abdomino-sacral amputation with abdominal colostomy (Quenu-Hartmann type).

(a) The simple Kraske type, or sacro-perineal amputation of the rectum, consists of an attack through a posterior parasacral incision—an amputation of the tumor-bearing part of the rectum and the anus, and a colostomy performed by implanting the severed end of the gut in the sacral wound. The coccyx is removed, the posterior layer of the pelvic fascia incised, the growth located. The peritoneum of the cul-de-sac is opened on both sides of the rectum, the vessels of the mesentery ligated, and the rectum pulled down. The peritoneum is then closed by suture. The growth, lower rectum and anus, are then amputated using clamps, and the lower end of the gut implanted into the sacral wound. The wound is then closed with drainage. (If the tumor is high enough to make saving the sphincter possible, a resection with end-to-end anastomosis may be performed instead of an amputation.)

This operation has been largely used in the past, and had in its favor its simplicity—the absence of shock, and an extremely low operative mortality. Its disadvantages are mainly the lack of an opportunity to explore the abdomen—and of much less importance, the inconvenience of a colostomy placed in the sacral region.

This operation has been used very infrequently in the recent cases in this series. In later years it has been used as the operation of necessity when the operation of choice was contra-indicated. It was used thirty-four times in the series with two deaths (6 per cent.). Of these deaths one occurred in a woman of seventy-three on the ninetieth day, from a late pulmonary complication—the other occurred on the second day in a severe cardiac.

This type of operation has been used in other clinics with the following results:

|  | Mortality | Cures |
|---|---|---|
| Hochenegg [6] (500 cases) ........... | 19% | 20% |
| Mayo [7] (27 cases—2 deaths) ........ | 7% |  |
| Cripps [1] (108 cases—8 deaths) ...... | 7% | 39% |
| Hartmann collected cases [8] (1616 cases—257 deaths) .......... .. | 16% | 551 recurrences in 805 cases traced |
| Berg (34 cases—2 deaths) ..:........ | 6% |  |

(b) The combined abdomino-sacral resection in continuity with an end-to-end anastomosis, and preservation of the anus and sphincters is performed by Doctor Berg in one sitting as follows:

The first part of the operation is a laparotomy through a low midline incision with the patient in the Trendelenburg position. The liver and retro-peritoneal lymph-nodes are first examined, and a search made for metastatic deposits. The tumor is then located, and adhesions to adjacent intra-abdominal viscera separated. An incision is made through the peritoneum of the meso-sigmoid on both sides. The superior hemorrhoidal vessels are ligated after deciding upon the level of resection, and marking this level with a tape. The lower sigmoid and rectum are mobilized as much as possible by blunt dissection. The blood supply of the part of the gut which is to remain is investigated and assured. A protective pad is placed in the abdomen under the line of incision, and a temporary closure of the abdomen is made with through and through silk sutures.

The patient is then placed on his right side. An incision is made along the left border of the lower sacrum and curved around the coccyx. The coccyx is removed. After incision of the intervening peri-rectal fascia, the mobilized rectum is drawn down through the sacral wound. The wound is now protected by pads and a resection in continuity performed between clamps, using the tape as a guide to the upper level. A margin of healthy gut must be excised on both sides of the growth. An end-to-end anastomosis is performed with chromic catgut sutures after inserting a rubber tube through the anus and up past the level of anastomosis. Ample drainage is provided and the muscles and skin closed with interrupted sutures. A dressing is placed over the wound.

The patient is now replaced in the Trendelenburg position. With clean gloves and gown, the abdomen is re-opened, the pad removed—and the pelvic peritoneum repaired so as to extraperitonealize the anastomosis. The gut is again inspected to be sure of the blood supply, and the abdomen is then closed without drainage. The anastomosis, of course, usually leaks, as the gut in this location lacks a complete peritoneal covering. However, the fecal fistula which develops always closes after a period. With a proper preliminary preparation of the bowels, the posterior wound becomes a healthy granulating wound before it is exposed to the fecal discharge, so that toxic absorption from this area does not ordinarily become a factor in the post-operative course.

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This combined operation has on occasions been completed in an hour, and the records will show that the operation does not often produce severe shock. Two deaths in fifty-four cases were ascribed to shock.

The chief advantage of this operation is that it leaves the patient a normally functioning anus with complete control of the bowels. A tendency to stricture formation at the site of anastomosis occurs in some of the cases, but dilation with bougies effects a rapid improvement of this condition.

(c) The Quenu-Hartmann operation used in this series is an abdomino-sacral amputation of the rectum with abdominal colostomy. A laparotomy is performed through a midline incision with the patient in the Trendelenburg position. An exploration is made, the peritoneum in the cul-de-sac is incised on both sides of the sigmoid, and this incision is carried across the serosal covering of the sigmoid. The gut is mobilized and the upper level of resection decided upon. The blood supply to the lower sigmoid is ligated. The gut is tied with tapes, divided between the two tapes and the mucosa is carbolized. The lower fragment along with the affected mesocolic glands are now pushed down into the pelvis, and the pelvic peritoneum is repaired—extraperitonealizing the fragment to be removed. The upper fragment of sigmoid is now implanted into the abdominal wall through the incision or a separate stab wound, to form a colostomy which will be opened several days later. The abdominal wound is closed in layers.

The patient is then placed on his right side—an incision made over sacrum and coccyx, and extended around the anus which has previously been closed by suture. The coccyx is removed. An incision is made in the fascia, and the rectum is pulled out through the wound, and removed en bloc down to the anus. The wound is then closed with drainage. This method would seem to be ideal from the standpoint of radicalism as a thorough removal of the diseased area can be accomplished. Moreover there is a great shortening of the period of hospitalization when this method is used, and the wounds usually heal rapidly and cleanly.

*D. Choice of Operative Procedure.*—In selecting the proper procedure to use in a case of rectal cancer, the main objective must be kept prominently in mind, *i.e.,* the complete removal of all disease. All secondary considerations must be sublimated to this issue.

Cancer of the rectum spreads in three ways. (a) By direct extension. (b) By way of the blood stream. (c) By way of the lymphatic stream.

(a) Handley [9] in 1910, reported one case in which he found an extensive spread of carcinoma along the submucous lymphatics in the wall of the gut beyond the gross limits of the tumor. This report led surgeons to question whether the many recurrences were not due to the fact that the gut was being resected too close to the visible growth, leaving behind gut with affection of the submucous layer. However, few of our recurrences have occurred higher up in the gut wall, or at the site of anastomosis. They are more apt to appear in other situations, in the scar, liver and retroperitoneal glands.

It appeared that the importance of Handley's report was exaggerated

when in 1914, Cheatle [10] reported the results of some interesting observations, which showed that Handley's was a rare case, and that in most cases the submucous spread does not extend further than the extramural lymphatic spread. Therefore a wide removal of the bowel far beyond the visible involvement is not essential.

(b) Hæmatogenous extension of these tumors results from the invasion of the tributary veins mainly of the portal system with metastatic deposits in the liver. They may occur on any surface of the liver or concealed within the organ. Apparently the lower hæmorrhoidal tributaries which drain into the hypogastric vein become involved less often as judged by the infrequent occurrence of pulmonary metastases.

(c) Lymphatic extension occurs mainly in two directions. The lymphatics of the anus pass forward to the inguinal glands. Those from the anal canal pass up along the hæmorrhoidal vessels to the hypogastric chain. These lymphatics perforate the rectal wall both above and below the levator ani, the latter ones traversing the fat of the ischio-rectal fossa, and end in glands near the origin of the internal pudic artery in the pelvis. (Poirier and Cuneo.) The lymph-vessels of the ampulla of the rectum pass up to the sigmoid mesocolic glands which drain to the pre-aortic glands near the origin of the inferior mesenteric artery.

In order to investigate the intra-abdominal spread of the disease by both the hæmatic and lymphatic routes, a laparotomy is necessary. It would be unjustifiable to subject a patient to a radical rectal amputation if discoverable metastases were already present within the abdomen. Recognition of this point has led practically to the discarding of the simple Kraske type of operation, so that in the last six years of the series this latter procedure was used very infrequently (in six cases), and is now used in cases in which there are contra-indications to the more extensive procedures, particularly in very old, feeble or obese individuals.

It would be fortunate for the patient if the normal anal control could be preserved for him without sacrificing the main object of the operation, the radical removal of all tumor tissue. This anal control is of course dependent on the preservation of the sphincter muscles and their nerve supply.

The innervation of the sphincter comes mainly through the inferior hæmorrhoidal branch of the internal pudic nerve. It leaves the internal pudic in Alcock's canal, and traverses the ischio-rectal fossa to the sphincter muscle The ischio-rectal fossa contains lymphatics which drain the anal canal. So when the tumor is low, and these lymphatics may be involved, the ischio-rectal fossa must be cleaned out thus destroying the innervation of the sphincters. This does not apply, however, in cases in which the tumor is in the higher part of the rectum, and in those cases there would not be this objection to the retention of the sphincters.

The recent work of Villemin [12] and his co-workers has shown that the third valve of Houston is the borderline between what they term the high rectum and the low rectum. Growths exclusively above this level do not

drain laterally or downward, but only upward. It is in these cases, where the tumor is high enough to avoid lymphatic extension through the ischio-rectal fossæ that the combined abdomino-sacral resection is chosen, so that the sphincters and anus may be preserved. It is very gratifying to find that some of our patients are perfectly well years after resection for carcinoma, with perfect control of the bowels through the normally situated anus. Blake[13] also in a recent report cites a patient well fourteen years after operation with normal sphincter control.

If any part of the tumor lies lower than the third valve of Houston the sphincters must be sacrificed, and a colostomy must be made. An abdominal colostomy is preferred to one in the sacral region for several reasons. It can be better cared for by the patient and kept cleaner, being visible to him. With an abdominal colostomy there need be no stinting in the amount of gut amputated. There seems to be a greater tendency for scar contraction of the stoma requiring repeated dilatations when the colostomy is in the sacral region. Also in this latter location there is often a tendency to prolapse.

In those cases in which the tumor extends below the third valve of Houston, the Quenu-Hartmann type of operation with its abdominal colostomy is preferable. This operation is also selected if for any reason an anastomosis cannot be performed without tension.

A preliminary colostomy is advocated by some authors. In cases with symptoms of obstruction, there can be no disagreement with this viewpoint, but in non-obstructive cases a preliminary colostomy is unnecessary, and is undesirable. Its presence increases the risk of infection if a second incision for the major operation is to be made through the abdominal wall. It leaves less freedom for mobilization of the tumor.

Stimulated by the high mortality of the combined operation in their cases, particularly by the deaths ascribed to surgical shock, a number of operators have advised dividing these operations into two stages hoping in that way to lower the mortality. Several plans have been advanced for these two stage operations.

Lockhart-Mummery[14] limits the first stage to a colostomy with exploration of the abdomen. He then leaves the entire mobilization of the tumor and its extirpation for the second operation, performed from the back. This plan may work well for the low tumors, but is not intended for the tumors at the recto-sigmoid junction. In his operation the patient is always left with a blind loop of sigmoid below the colostomy to which accidents may occur, and which occasionally may result in a permanent posterior fistula.

Jones[15] performs some mobilization of the tumor, and a dissection of the pelvis at the first operation, preserving the blood supply to the lower bowel by ligating the inferior mesenteric artery just below the left colic branch. A colostomy is sometimes added. An extraperitoneal amputation is performed at the second operation through a sacro-perineal incision.

Mayo[7] remodelled the Quenu-Hartmann operation as a two-step procedure. The first stage was to sever the sigmoid, implant the upper end as a colostomy, and after mobilizing and closing the lower fragment, pushing it into the pelvis where it was extraperitonealized. About one week later the second stage was performed as a sacro-perineal amputation. In 1912, he reported a death from perforation of the distal segment while the patient was awaiting the second stage.

This accident stimulated Coffey [16, 18] to improve upon this operation. Coffey severs the sigmoid, uses the proximal fragment for the colostomy, inverts the closed lower fragment pulling it through the anus when possible, and then provides a tampon drainage suprapubically in the male, and vaginally in the female, to seal off the septic field from the peritoneal cavity. The second stage is an amputation through the sacro-perineal route.

Any adequate two-stage operation should provide for mobilization of the tumor from the abdominal side and consequently in the first stage. Otherwise the thoroughness of the removal of the upward spread of the tumor cannot be assured. This mobilization, if adequate, requires considerable dissection and opening up of fresh tissue planes—all of which are thus made into receptacles for deposit of tumor cells through the severed lymphatic channels while waiting for the second operation. The cancer remains in the pelvis during this time pouring out cancer cells through the lymphatics, which have been opened up at the first operation.

This is an important objection to the two-stage operation. Our series will show that that part of the mortality due to shock is small, and therefore we do not believe it necessary or wise except in very exceptional cases to divide the operation into two stages. All except two of the operations in this series have-been performed at a single sitting.

## SUMMARY

The location and extent of the tumor and general condition of the patient determine the type of operation to be used.

(1) The simple Kraske type of operation should be reserved as the operation of necessity for patients whose general condition does not warrant the risk of a more extensive procedure (obesity, old age, deficient vital organs).

(2) The combined abdomino-sacral operation with resection in continuity is selected for cases in which the growth is high in the rectum as in these cases the lymphatic involvement does not extend through the sphincters or the ischio-rectal spaces. Bowel control can then be preserved.

(3) The Quenu-Hartmann type is used when an anastomosis cannot be safely performed, and in cases where the mesenteric glands are so involved as to require a high resection of the sigmoid; and particularly in all cases which involve that portion of the rectum below the third valve of Houston.

(4) In non-obstructive cases each of these operations should be performed at one sitting.

E. *Mortality.*—In considering the statistics of this series all deaths within one month after operation are included in the operative mortality. There were three additional deaths in the hospital occurring thirty-six days, ninety days, and six months after operation. These three deaths occurring so long after operation are not included in the operative mortality, but are discussed in the following paragraph.

There were twenty-five deaths in the hospital, four on the first day, eleven occurring on the second to the seventh days, seven more in the first month, and three after one month. One death occurred ninety days after operation in a woman of seventy-three with pulmonary signs. One man who died of

metastases six months after operation had remained in the hospital simply because he could not be cared for at his home. A death on the thirty-sixth day was due to pulmonary embolism (autopsy). Omitting these three deaths which occurred more than one month after operation, we have an operative mortality for the entire series of 18 per cent. (20 per cent. including the three cases mentioned above). In comparing these figures with those of other surgeons, it must be remembered that the limits of operability has been stretched to 84 per cent. in this series, so that probably more bad risks have been included than were included in the other reported series with which we are familiar. More conservative selection of cases would have decreased the mortality, but would also have refused their only chance of cure to many of these patients.

*Causes of Death.*—(a) *Infection.* No deaths from infection occurred in the simple Kraske or Quenu-Hartmann types. Five occurred among the combined resections with anastomosis. Our experience has varied from that of Mayo,[15, 17] who ascribes a large proportion of his mortality to sepsis. Of the deaths due to infection, one was due to a gangrenous cystitis and pelvic abscess, two to peritonitis, one to a severe infection of both wounds, and one more probably to peritonitis. In one case a preliminary colostomy was first performed for obstruction. The patient also suffered from myocarditis and nephritis, and was a diabetic. She developed peritonitis following the radical operation performed two weeks after the colostomy was established.

(b) *Pneumonia.*—Pulmonary complications were responsible for one third of all the deaths. Of the nine deaths in the Quenu-Hartmann cases, five were ascribed to pneumonia. This was the proven cause of death by autopsy in one case, by X-ray in two cases, and by medical consultation with the late Doctor Brill in one case. In the future it is almost certain that the pulmonary complications will be lessened by the use of spinal anæsthesia. Had these pulmonary deaths been saved in this series, the mortality of the Quenu-Hartmann group might have been as low as 12 per cent.

Diabetes was a factor in three of the fatal cases.

(c) *Shock.*—Most important are the five deaths ascribed to shock. We wish to call attention to each of these cases.

(1) In this case, the operation was of the Quenu type, but a panhysterectomy had to be included. The time was one hour and fifty-five minutes. There was a sudden death five hours after operation charted as "pulmonary embolism or acute dilatation of the heart", but no autopsy was obtained, and the death may have been due to shock.

(2) This was really an inoperable case, in which the rectal irritation, bleeding and tenderness were so severe that a palliative removal of the rectum was performed. The patient had come up from Mexico for an operation as a last resort, and was in very bad shape. The operation required one and one-half hours—during which a transfusion was required. The bladder was adherent to the growth, and small intestine required resection. Death occurred on the following day.

(3) This patient died in twenty-four hours. There was considerable oozing from the posterior wound.

(4) This patient died in three hours. It is not certain whether he did not have an internal hemorrhage.

(5) This was a woman of sixty in whom hysterectomy was required as part of the operative procedure. The time was one hour and forty-six minutes. Death occurred within twenty-four hours.

Of the five patients who were lost from shock, three had complicating conditions, which could hardly have been managed by a two-stage procedure with any different result. The other two lost considerable blood, and the shock was secondary to hæmorrhage.

It is difficult to see how a two-stage procedure would have saved these cases, other conditions, remaining unaltered. Certainly a lowered mortality from shock is the main attractive point in favor of dividing the operation into two parts. In our series we doubt whether any of these deaths would have been avoided by using a two-stage procedure.

In this series only two operations were done by two-stage technic. Both of these patients died. Eliminating these two cases, for purposes of comparison, we have a mortality of 16 per cent. for the single stage operation.

Some significance must be attached to the fact that the private patients had a mortality lower by one third than that of the ward patients.

Private cases ............63 cases........10 deaths or 16%
Ward cases .............64 cases........15 deaths or 24%

The private patients come to the surgeon earlier, are in better general condition, and have the benefit of special nursing care.

For comparison we borrow from the literature the following data:

| | No. Cases | Oper-ability | No. Radical Opera-tions | Type Operation | Mor-tality |
|---|---|---|---|---|---|
| W. J. Mayo,[19] 1897–1909..... | | | 120 | All types | 16% |
| W. J. Mayo,[17] 1893–1915..... | 753 | 53% | 430 | All types | 15.5% |
| W. J. Mayo,[7] 1910–1912..... | | | 14 | 1 stage comb. | 35% |
| | | | 30 | 2 stage comb. | 13% |
| W. J. Mayo,[17] 1913–1915..... | 277 | 71.8% | 199 | All types | 12.5% |
| Quoted by Mayo[7]: | | | | | |
| Miles................. | | | 42 | 1 stage abdomino per-ineal | 40% |
| Wallis............... | | | | 1 stage abdomino-per-ineal | 40% |
| Hartmann............ | | | | 1 stage abdomino-per-ineal | 25% |
| Kraske............... | | | | 1 stage abdomino-per-ineal | 40% |
| Hartmann,[8] collected cases... | | | 260 | Comb. Kraske | 37% |
| Chalier and Perrin,[4] 1913..... | | | 126 | Quenu-Hartmann | 42% |
| | | | 208 | Comb. Kraske | 40% |
| Jones[15]...................... | | | 16 | 2 stage | 18% |
| Bach,[2] 1919................. | | | | Quenu-Hartmann (Selection of cases) | 20% |
| Lynch,[5] 1918.............. | 491 | | 335 | All types | 16% |
| Berg...................... | 151 | 84% | 127 | All types | 18% |
| | | | | 1 stage comb. Kraske | 19% |
| | | | | 1 stage Quenu | 26% |
| | | | | Omitting two-stage operations in both of which death occurred | 16% |

STATISTICS OF SERIES

### I.

Number of Radical Operations ............ 127

Operative Mortality ...................... 22 cases  18%

Operative Mortality inclusive of 3 deaths
after one month ...................... 25 cases  20%

### II.

| Type of Operation | No. of Cases | Deaths | Mortality |
|---|---|---|---|
| Simple Kraske ................ | 34 | 1* | 3% |
| Combined Resection .......... | 55 | 10† | 19% |
| Quenu-Hartmann Amputation .. | 34 | 9 | 26% |
| Atypical ..................... | 4 | 2 | 50% |

### III.

*Cause of Death.*

|  | Thoracic | Infection | Shock | Miscellaneous |
|---|---|---|---|---|
| Simple Kraske............................ | 2 | 0 | 0 | 0 |
| Combined Resection...................... | 2 | 5 | 3 | 2 |
| Q-H Amputation......................... | 7 | 0 | 2 | 0 |
| Atypical................................ | 1 | 1 | 0 | 0 |
| Totals................................ | 12 | 6 | 5 | 2 |

Thoracic causes of death
{
Pneumonia............................ 8‡
Cardiac.................................. 2
Pulm. Emb............................. 1
Cerebral Emb.......................... 1
}

Infection
{
Peritonitis.............................................. 3 (plus 1?)
Severe Wound inf ................................ 1
Pelvic abscess......................................... 1
}

Miscellaneous
{
Metastases—cachexia (6 months after operation)..... 1
Prolapse of viscera and intestinal obstruction........ 1
}

### IV.

*Time of Death.*

| | 1st day | 2–7 day | 8–30 day | 31st day plus |
|---|---|---|---|---|
| Simple Kraske ........... | 0 | 1 | 0 | 1 |
| Combined Resection ...... | 3 | 2 | 5 | 2 |
| Q-H Amputation ......... | 1 | 6 | 2 | 0 |
| Atypical ................ | 0 | 2 | 0 | 0 |
| Totals .............. | 4 | 11 | 7 | 3 |

*F. Ultimate Results.*—Unfortunately ultimate results in many of these cases are unobtainable. The ward patients are extremely difficult to follow

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* One additional death on 90th day.

† Two additional deaths on 36th day and 6th month.

‡ In four of these eight cases, there is indisputable evidence of pneumonia; in the other four cases it cannot be proven that pneumonia was the actual cause of death but this seems probable from the records.

in New York City where this type of patient moves frequently and often leaves no trace.

The private patients have been followed more easily. The follow-up records of the private cases have been furnished to me from Doctor Berg's office records.

| *Ward cases* | | *Private cases* | |
|---|---|---|---|
| 64 | Total no. of cases............. 127 | 63 | |
| 15 | Deaths in hospital .......... 25 | 10 | |
| — | | — | |
| 49 | Survived operation ........ 102 | 53 | |
| 30 | Not traceable 1928.......... 43 | 13 | |
| — | | — | |
| 19 | Result known .............. 59 | 40 | |
| 17 | Deaths probably from cancer or recurrences ............ 41 | 24 | |
| — | Died of other causes—free of cancer .................. 2 | 2 | |
| 2 | Known to be well.......... 16 | 14 | |
| 3% | | 12½% | 22½% |

Sixty per cent. of the survivors of the operation in ward cases are not traceable, and these records are therefore of little value. In the private cases, however, the results to date are known in 80 per cent. of the cases. A more detailed analysis of the private cases is therefore appended.

### Private Cases.

#### Simple Kraske

No. of cases........................ 14
No record ......................... 4
Op. death ......................... 2

Died presumably of cancer.....4 $\begin{cases} \text{1 yr.} \\ \text{1 yr.} \\ \text{1½ yrs.} \\ \text{8 yrs.} \end{cases}$

Dead of other causes, 1—3 yrs., no known recurrence

Well to date.................3 $\begin{cases} \text{5 yrs.} \\ \text{9 yrs.} \\ \text{11 yrs.} \end{cases}$

#### Quenu

........................ 14
........................ 4
........................ 2

Died presumably of cancer.....5 $\begin{cases} \text{1 yr.} \\ \text{1 yr.} \\ \text{1 yr.} \\ \text{1½ yrs.} \\ \text{4 yrs.} \end{cases}$

Well to date.................3 $\begin{cases} \text{4 yrs.} \\ \text{6 yrs.} \\ \text{8 yrs.} \end{cases}$

#### Combined Kraske

No. of cases........................ 33
No record ......................... 5
Operative death ................... 5

Died presumably of cancer..15 $\begin{cases} \text{1..4 mos.} \\ \text{9..1 yr.} \\ \text{2..2 yrs.} \\ \text{1..3 yrs.} \\ \text{1..4 yrs.} \\ \text{1..5 yrs.} \end{cases}$

Died of other causes—1-6 years

#### Atypical Cases

........................ 2
........................ 1 well 12 years
........................ 1 operative death

Well to date.................7 $\begin{cases} \text{4 yrs.} \\ \text{7 yrs.} \\ \text{7 yrs.} \\ \text{10 yrs.} \\ \text{10 yrs.} \\ \text{10 yrs.} \\ \text{11 yrs.} \end{cases}$

*Combined results of private cases*

Cases ................................................... 63
Operative deaths ......................................... 10
                                                         ——
Survivors .............................................. 53

13 no record

Died of cancer ...........24 {
15..1 yr.
4..2 yrs.
1..3 yrs.
2..4 yrs.
1..5 yrs.
1..8 yrs.
1..9 yrs.
}

Well...................14 {
2.. 4 yrs.
1.. 5 yrs.
1.. 6 yrs.
2.. 7 yrs.
1.. 8 yrs.
1.. 9 yrs.
3..10 yrs.
2..11 yrs.
1..12 yrs.
}

Died of other causes...........2 {
3 yrs.
6 yrs.
}

It may be noted that of the sixty-three private cases there were thirteen five-year cures up to the early part of 1928. It must also be noted that one patient died in the fifth year from a metastasis in the lung, and one in the eighth year of a recurrence in the prostate. How long an interval after operation should be required as evidence of cure is therefore open to argument. The seven, five-year cures among the cases which were operated by the method which involves the saving of the sphincters are evidence that in properly selected cases it is possible and distinctly worthwhile to avoid a colostomy.

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# A STUDY OF THREE HUNDRED FORTY-THREE SURGICAL CASES OF INTESTINAL OBSTRUCTION

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The outstanding consideration in any study of intestinal obstruction is the appalling mortality. In no acute abdominal condition is the death rate such as to give us of the medical profession any reason for complacency, but in none of them does it approach the rate of intestinal obstruction, in which, although ordinarily stated to be between 30 and 40 per cent., actually it ranges between 55 and 65 per cent.

In the present study, which is based on 343 surgical cases treated during the last five years at Charity Hospital and Touro Infirmary (New Orleans), and which includes all instances of complete obstruction with the single exception of post-operative ileus (non-mechanical obstruction), there were 209 deaths, a gross mortality of 60.9 per cent. The unrevised figures from the two hospitals, which include all cases diagnosed as intestinal obstruction, no matter what their degree and type, give a mortality for each institution of slightly less than 40 per cent., whereas our revised figures show a mortality for Charity Hospital of 65 per cent. and for Touro Infirmary of 50.5 per cent. This difference entirely corroborates the general belief that the mortality for the condition is very much higher than it is ordinarily supposed to be, and nothing is to be gained by denying the discrepancy. The bald truth is that we are stultifying ourselves in this matter, we are accepting the figures for all sorts of cases—and even they are black enough—as the figures for the acute, complete cases, which actually are from 20 to 30 per cent. higher.

The character of acute abdominal pathology is not always to be gauged by the time which has elapsed since the onset of symptoms, for fatal complications may ensue in an unbelievably short time, but the prognosis is invariably dependent on it, and it is safe to assert as a working rule that the longer surgical intervention is delayed the smaller will be the patient's chance of recovery. This is particularly true of intestinal obstruction, in which actual figures show that the mortality rises approximately 1 per cent. with each hour of procrastination, and in which, as Moynihan puts it, any mortality over 10 per cent. should be regarded as the "mortality of delay".

In complete intestinal obstruction death is inevitable unless surgery is done, and the fact that death is so often a concomitant of surgery is no reflection upon that mode of treatment. Instances of spontaneous rectification of the pathology are so rare that they may be set down as chimerical, and the cold facts are that the alternatives are surgery or death, and that sometimes there is no alternative, for I venture to say that probably 20 per

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cent. of these patients are operated on when there is not more than a 1 or 2 per cent. chance for their recovery. They are frankly moribund and operation is simply the surgeon's habitual gesture, as it were, and the patient's viaticum. As Lincoln Davis vividly puts it, no surgeon operates for a "batting average". If he did, if he selected for operation only those patients in whom there was a chance for cure, his surgical record would undoubtedly be improved, but he would be the poorer surgeon for it, for he would have withheld from dying men and women the mechanical relief which provided for them their only frail hold on life.

As to the reason we receive these patients in such desperate straits, that is another matter, and for it are responsible all three people finally implicated in the case, the patient himself, the medical man and the surgeon. The patient himself has no small responsibility for his own condition, though I do not recollect that I have anywhere seen this point stressed. In the first place, the instinct of the average lay person seized with abdominal pain is to doctor himself, and I know no more pernicious belief than the almost universal one of regarding a dose of salts or some similar medication as the panacea for all intraabdominal ills. In this series, not one patient but many patients doctored themselves in this manner, not only for one or two days, but for four, five and six days. In the second place, fear of surgery plays no small part in their delay in seeking medical consultation. I have repeatedly seen patients, and have finally operated on them, who were "opposed to surgery", who were willing to trust themselves to the non-existent chances of medical recovery in a condition which only surgery could aid merely because they feared the knife. In this series four patients after their admission to the hospital refused operation for hours and even days, and in a group of sixteen non-surgical cases also reviewed, six patients likewise refused operation, in two instances being removed from the institution by their relatives when they were almost moribund. Within sight of water they perished of thirst. You cannot operate on people against their will, and education of the laity to the fearful consequences of delay is the first step toward reducing the mortality of intestinal obstruction.

When I speak of the responsibility of the medical man I know that I am treading on dangerous ground. I shall have something to say, in due course, of the surgeon and his part in this sorry story, but it cannot be denied that most often he does not see the patient until it is too late for his or any other mortal ministrations. The medical man does see the patient first, and too often he does delay, giving cathartics and enemata, making elaborate laboratory tests, hoping from hour to hour and day to day that expectant treatment will halt the steadily downward course of the pathology, until it is all too evident that no treatment at all will avail. Sir William Taylor may be too bitter when he speaks of the "inexcusable ignorance or carelessness of general practitioners, who see these cases early and treat them medically, thereby laying themselves open to actions at law for malpractice if not for manslaughter", but there is more than a germ of truth in his remarks.

Yet surgeons also delay. Twenty-eight of the thirty-two patients in this series who were operated on after a delay in hospital of from twelve hours to five days had themselves no share in the delay; it was the surgeons who waited, and the fact that there were twenty-two deaths in this particular group makes the record a very black one. Vick's idea is not altogether a poor one, that the symptoms of intestinal obstruction be made a routine question in all medical examination papers, both to impress the student with the seriousness of the condition, and in the hope that if he remembers the diagnosis under these circumstances, he is not so likely to overlook it when he meets the condition in actual practice.

In another regard, too, the surgeon is open to blame—all of these operations are of the gravest type, and yet too often, chiefly because of the seniority system in our hospitals which Codman and others have inveighed against, they are undertaken by young, inexperienced men, who may possess manual dexterity but who lack that greater gift, the surgical judgment which comes only with the years. It is quite true that even an inexpertly performed operation done early may give better results than the most finished surgery done later, but in these days of many hospitals and many available surgical consultants, such a choice need seldom be made.

Another reason for the high mortality of intestinal obstruction is that its dual character is so often overlooked. It would seem logical, since mechanical blocking of the intestinal tract is the occasion of the pathology, that the mere removal of the obstruction would result in a cure, but this is far from the truth. The mechanical obstruction with the consequent stoppage of the fecal current is only the beginning; it is not nearly so important as the sequelæ, interference with the circulation, damage of the bowel wall with ultimate gangrene, and the production of toxins. It is for this reason that only in the early stages is the mere relief of the obstruction sufficient. Indeed, in the late stages, the relief of the obstruction, which permits a rush of toxic substances into the yet intact bowel or which permits the return of the circulation to a necrotic loop, is in itself a very dangerous procedure, and we are confronted with the paradoxical situation of doing the patient harm by the very means employed to do him good.

Nor is this all of the dilemma. Even in apparently early cases mere relief of the obstruction may not be sufficient, for a paralysis, particularly if there has been marked distention, may persist after the original mechanical trouble has been corrected, while in late cases, even if the toxemia be relieved by drainage of the bowel and other adjuvant measures, the patient may die of his unrelieved primary condition. Finally, even the fact that the patient is seen early and is in apparently good condition does not necessarily mean that lethal toxins have not already been produced in fatal quantities. In short, operation for intestinal obstruction is a three-fold problem, involving as it does not only the relief of the actual obstruction, but also the management of the damaged bowel and the combating of toxemia.

The clinical aspect of every case of intestinal obstruction is the essential

aspect, yet even here confusion arises from the fact that in the operable stage any or all of the classic symptoms may be lacking. Surgical textbooks are decidedly misleading on this point, for they tend to stress the terminal symptoms, "the signs of lost opportunity", as Sampson Handley calls them, rather than the initial symptoms. It is surprising to note how often a carefully taken history will elicit vague premonitory symptoms, which seem to warrant Deaver's statement that few abdominal catastrophes are the result of "virgin pathology", and Moynihan's, that most of them "mark an abrupt transition from the quiescent to the acute stage in a disorder of long standing". In about a fifth of the cases in this series the patients furnished histories of vague abdominal distress culminating finally in acute attacks, though such cases are in no way allied to the usual "chronic intestinal obstruction". Such a careful history will also bring out the existence of a hernia, for instance, even before the physical examination discloses its presence, or will elicit the fact of a previous operation. That the latter is a particularly important consideration is evident from the fact that 24.2 per cent. of the patients in this series gave a history of previous abdominal operation, chiefly for pelvic conditions or acute appendicitis, while in Finney's series 40 per cent. of the patients had previously been operated on. In fourteen of the cases in my series, 16.9 per cent. of this special group, the surgery had been done within the preceding three weeks. These figures, I might say parenthetically, make plainly evident the necessity for early operation in acute appendicitis, so that drainage may be avoided, and also point to the importance of covering all raw surfaces in pelvic work.

It is commonly agreed that the earliest symptom of acute intestinal obstruction is pain, usually sudden and acute, at first colicky and intermittent, but finally continuous, and always continuous from the onset if the mesentery is implicated. It may originate in the epigastrium, though more usually it originates about the umbilicus, and finally it involves the whole abdomen. It was complained of by three-quarters of the patients in this series, and Tuttle and Finney give roughly the same proportion.

Vomiting was complained of by practically the same number of patients, and is unquestionably the second most important symptom. The quantity and type depend upon the site of the obstruction, and in colonic involvement this symptom may not be apparent until the late stages. Usually frequent and copious, the vomitus consists first of gastric contents, then of bile-stained fluid, finally of true fecal material. This fecal vomiting is ultimately effortless and is due to the high pressure of fluid and gas, being comparable to the escape of gastric contents through the nose and mouth at or just after death, when putrefactive distention of the abdomen comes on. It is, as Sampson Handley says, "not a symptom of disease but rather a sign of impending death". According to the records, it was exhibited by forty-five patients in this series, of whom thirty-five died, and my personal opinion is that in the ten patients who survived, the vomitus was not of the true fecal type but consisted rather of small bowel contents. It must be

remembered, too, that obstruction of the small bowel may check or prevent fecal vomiting, since the mechanical obstruction may act upward as well as downward.

Absolute constipation, while undoubtedly a frequent symptom, must be accepted as such with caution. If it exists it is pathognomonic, but it may not always exist. It was present in only about half of the cases in this series and other studies corroborate these figures. In intussusception and mesenteric thrombosis frequent thin, watery, blood-stained stools are more usual than obstipation, and while obstruction in the right half of the colon clinically is evident as obstipation, in the left half diarrhea is the rule. Moreover, the higher the obstruction is located the longer will it take to demonstate it, even with the aid of enemata and flushes.

Physically we are in even worse case. It is true that distention is a constant and progressive feature of intestinal obstruction, but it is seldom present at the onset. In this series as well as in Tuttle's, it was noted in only a third of the cases, and in Finney's series it was noted in only half. In acute cases it tends to be rather late, and it is always late when the upper small intestine is implicated. As a rule, the lower the obstruction the prompter and more pronounced the distention is likely to be, and in obstruction of the lower colon and sigmoid it may seriously embarrass respiration.

Tenderness is always a late feature, seldom being apparent until after distention has occurred. When localized peritonitis is present rigidity is usually associated with it, but rigidity is not a constant sign, and its absence differentiates intestinal obstruction from other abdominal diseases of an inflammatory nature. Visible peristalsis is pathognomonic but it can be demonstrated only rarely, and the same is true of most of the other physical signs which are real aids to diagnosis.

In the present series all of the symptoms and physical signs ordinarily ascribed to intestinal obstruction were present in the collective group, but in no single instance was the full classic syndrome present. In eleven cases, seven of them fatal, the diagnosis was clouded by the fact that definite dietary indiscretions preceded the attack. Emaciation, dehydration and acidosis were noted in individual cases, and uremia played a part in the fatal outcome in three patients who were admitted with complete suppression of urine. In six patients with umbilical and ventral herniæ, all of whom died, the weight ranged from 250 to 400 pounds.

Shock is a marked feature in certain types of intestinal obstruction, always being present in the early stages when the circulation is affected and always being a concomitant of toxemia in the late stages. Indeed, the toxemia of intestinal obstruction is now almost universally agreed to be allied with surgical shock. Shock is also always associated with the extreme distention present late in the condition, no matter what the primary cause has been.

Since intestinal obstruction is a condition which is not primarily inflammatory, elevations of temperature, as will be seen from Table I, are not usual in the early stages, though definitely or slightly subnormal tempera-

tures are quite common. In this series the temperature range was from 94 to 105° F. Of the ninety patients who exhibited a temperature over 100°, 71.1 per cent. died, this being 30.6 per cent. of the total number of deaths. Of the 118 who exhibited a temperature below normal, 72.8 per cent. died, this being 41.1 per cent. of the total number of deaths. That is, roughly 71 per cent. of the patients who died exhibited a temperature below normal or over 100 degrees.

TABLE I.

*Temperature Range on Admission.*

| Temperature | Number cases | Per cent. |
|---|---|---|
| Below normal | 118 | 34.4 |
| To 100 | 135 | 39.4 |
| To 102 | 72 | 21.0 |
| Over 102 | 18 | 5.2 |

Elevations of the pulse rate are quite usual, and, in conjunction with a subnormal or normal temperature, offer valuable diagnostic aid. In this series the pulse range was from 50 to 180 (Table II), the rate in many instances being so rapid that counting was not possible. Of the 153 patients with a rate over 100, 70 per cent. died, 50.2 per cent. of the total number of deaths.

TABLE II.

*Pulse Range on Admission.*

| Pulse rate | Number cases | Per cent. |
|---|---|---|
| Below 70 | 8 | 2.3 |
| Normal (70-84) | 82 | 23.7 |
| To 100 | 100 | 29.3 |
| To 120 | 78 | 22.7 |
| Over 120 | 75 | 21.9 |

Practically all of the forty-two white counts in the series which were over 12,000 (the range being to 35,000), were in the group of strangulated or circulatory obstructions. The chemical changes included principally a fall in the blood chlorides and a rise in the $CO_2$ combining power of the blood. In one instance the latter reached the extraordinary figure of 113, the patient recovering after a very stormy convalescence. The rise in the non-protein blood nitrogen is quite constant in these cases, and in moribund patients, particularly if an accurate history cannot be secured, it may lead to a mistaken diagnosis of uremia.

The last few years have witnessed extensive and valuable work, both experimental and clinical, on the chemistry of intestinal obstruction, and the work of Whipple, Stone, Scholefield, Hermann, Gatch, Trusler and Ayres, to mention only a few of the many investigators, has been of inestimable aid in establishing the proper pre-operative and post-operative treatment and in confirming the necessity for prompt operation. On the other hand, the true nature of the toxin produced has not been identified, and the

results of the experimental work have often been contradictory, largely because it has not been based on the same premises. Without depreciating in any way the immense value of this work, I would echo Hertzler's warning, that in our zeal for chemical investigation we must not forget that after all our main concern is with the damaged bowel wall which is the primary source of the trouble.

With such a confusing array of symptoms and signs, how is a diagnosis to be made? Of chief importance is the securing of a careful history, particularly with reference to the symptoms of the attack and their relation to each other. Special emphasis should be laid on the character of the pain, for that is the chief diagnostic sign. Moynihan says that it is safe to say that any acute abdominal pain not promptly relieved by a small dose of morphia—which, by the way, should be a remedy and not a refuge—will require operation, and other writers emphasize the fact that any abdominal pain which lasts more than six hours in a previously well patient justifies an exploratory operation. It cannot be too strongly stressed, in this connection, that mere subsidence of the pain may in itself be a most misleading thing; the patient's well-being may arise not from a disappearance of the pathology but from the development of gangrene.

Next in importance is a careful physical examination, and Deaver, at this point, urges the importance of auscultation, either with the naked ear or with the stethoscope, mentioning the "ominously silent abdomen" of the late stages of the condition, in which the pulsation of the aorta is the only sound. It is frequently urged that constipation may be elicited as a symptom by the giving of two enemata, the first to empty the lower bowel, the second to demonstrate the obstruction. This is all very well if the lower bowel is implicated, but if the obstruction is high the method does not serve the purpose, and it is always time-consuming. Codman advises digital rectal examination and describes the empty rectum in which the walls crowd around the finger, while above is a sensation of tremendous intraabdominal pressure.

There is no time for a fine-spun laboratory diagnosis. Naturally a routine urinalysis is imperative, and a blood count will do no harm, though it is seldom of particular value. Blood chemistry is a prognostic and therapeutic aid, not a diagnostic measure chiefly, and with our present methods the procedure is still so complicated that time should not be wasted in securing the data. As for X-ray examinations, they are of little value without the administration of barium, and a barium meal, as I see it, has not the smallest justification in the face of even a suspicion of intestinal obstruction. I have in my day operated on patients for intestinal conditions who had just previously been given barium and I have no desire to repeat the experience.

In short, in this condition, operation is justified on mere suspicion. The important thing is to suspect, of course with reason, that intestinal obstruction exists, not to make a brilliantly detailed diagnosis. Speedy operation is the more warranted because practically all conditions which may be confused with it are amenable only to surgical treatment, and if cardiac, pul-

monary and renal disease are eliminated, then exploration is always less harmful than delay. The best authorities are agreed on this point. C. H. Mayo says that he has never seen a patient die as the result of an unnecessary exploratory incision, though he has many times seen death occur because it was made too late, and Finney suggests that it would be better to do "a few unnecessary exploratory operations on live patients than to continue the long and melancholly roll of hurried enterostomies on moribund patients".

Cope and Souttar are agreed that herniæ are the most frequent cause of intestinal obstruction, with intussusception, malignancy and adhesions or bands next in order. In my own series the order (Table III) is slightly different. As a rule, the commonest cause in childhood is intussusception, while in advanced adult life malignancy and herniæ are responsible for most cases. The small bowel is more likely to be involved than the large. In this series it was involved alone in 57.2 per cent. of the cases, and with the cecum (chiefly in intussusception) in 19.7 per cent., while the colon was involved in 17 per cent. and the sigmoid in 6.1 per cent.

TABLE III.

*Cause of Obstruction.*

| Pathology | Number cases | Per cent. | Mortality |
|---|---|---|---|
| Herniæ | 96 | 28.0 | 61.5 |
| Adhesions | 68 | 19.8 | 58.8 |
| Intussusception | 42 | 12.2 | 52.4 |
| Volvulus | 34 | 9.9 | 58.8 |
| Bands | 30 | 8.7 | 56.6 |
| Carcinoma | 17 | 4.9 | 88.2 |
| Thrombosis | 7 | 2.0 | 71.4 |
| Concretions | 3 | .9 | 66.6 |
| Miscellaneous | 19 | 5.6 | 52.6 |
| Unindentified | 26 | 7.9 | 84.6 |

The higher the obstruction the more quickly do symptoms develop, the more rapid and more fatal is the toxin, the more serious is the outlook, and the greater is the necessity for prompt surgical intervention. In the large bowel, on the other hand, while bacteria are more numerous, the production of the fatal toxin is less swift and the prognosis would undoubtedly be more favorable except for the fact that the majority of the obstructions of the lower bowel are due to malignancy of long-standing, so that the patient's condition is bad to begin with. In the chronic cases which have become acute the prognosis is better than in the immediately acute type, partly because a certain degree of intestinal immunity has been established, partly because long-standing distention has resulted in a sort of compensatory hypertrophy of the bowel.

Table IV, which gives the mortality for the various types of pathology found in this series, also gives the comparative mortality for Souttar's and Tuttle's studies, though, because of differences in classification, the comparison is necessarily incomplete. It should be said that the very high mortality

for carcinoma in my own series is due largely to the fact that several of the Charity Hospital patients recovered from their operations but remained in the hospital until death (in one instance this occurred fifteen months later) because they could not be cared for elsewhere. Otherwise the mortality would probably be considerably lower.

TABLE IV.

*Comparative Mortality.*

| Pathology | Miller | Souttar | Tuttle |
|---|---|---|---|
| Concretions | 66.6 | 50.0 | 100.0 |
| Carcinoma | 88.2 | 43.5 | 42.9 |
| Adhesions | 58.8 | 31.0 | 33.3 |
| Bands* | 56.6 | 33.0 | 55.6 |
| Intussusception | 52.4 | 22.0 | 71.4 |
| | | 35.0 | |
| Volvulus | 58.8 | 51.0 | 40.0 |
| Herniæ | 61.5 | 16.0 | 32.4 |
| | | 20.0 | |
| | | 35.0 | |

The duration of the illness, as we have already emphasized, is the clue to the mortality in the vast majority of cases, but it is extremely difficult, particularly with ignorant patients, to secure the duration accurately. This is the explanation, I believe, of the very high mortality in the present series for the first twelve hours (Table V), 29.4 per cent. being decidedly in excess of the 13 per cent. reported by Bowers, the 4 per cent. reported by Tuttle, and the 5 per cent. reported by Finney. In nearly all of the studies of which I have knowledge it is agreed that after the third day the mortality is rarely less than 50 or 60 per cent.

TABLE V.

*Mortality Based on Duration of Symptoms.*

| Duration | Mortality | Duration | Mortality |
|---|---|---|---|
| Under 12 hours | 29.4 | Under 72 hours | 63.4 |
| Under 24 hours | 52.9 | Under 96 hours | 72.8 |
| Under 36 hours | 50.0 | Over 96 hours | 84.0 |
| Under 48 hours | 59.6 | | |

For working purposes Sir William Taylor's classification of cases, based on the condition of the patient, is an excellent one. In the first group the patient is seen early and is in good condition, so that simple relief of the obstruction, plus routine pre-operative and post-operative treatment, will suffice for a cure. In the second group he is seen somewhat later, his condition is still fairly good, but because toxemia is an actual or potential factor, drainage of the bowel is instituted in addition to the relief of the obstruction. In the third group he is seen late, his condition is poor, toxemia is at least as important a factor as the primary obstruction, and only drainage of the bowel by jejunostomy is warranted. If the patient survives—as he usually

* Probably inaccurate.

does not—the necessary procedures for the relief of the obstruction are done later. That is, the condition of the patient must determine the type of procedure, and for that reason the figures of Table VI are not necessarily an interpretation of the value of any special operation.

TABLE VI.

*Mortality in Relation to Procedure.*

| Procedure | Number cases | Per cent. cases | Mortality |
|---|---|---|---|
| Release obstruction....... | 86 | 25.1 | 40.7 |
|    with drainage*....... | 30 | 34.9 | 56.6 |
| Drainage only* ......... | 72 | 21.0 | 87.5 |
| Resection ............... | 54 | 15.7 | 76.0 |
|    immediate anastomosis | 44 | 80.8 | 73.8 |
| Reduction† ............. | 49 | 14.3 | 32.7 |
|    with drainage*....... | 6 | 12.2 | 50.0 |
| Invagination ............ | 12 | 3.5 | 97.5 |
| Herniotomy (only)....... | 52 | 15.2 | 57.7 |
| Miscellaneous ........... | 18 | 5.2 | 66.6 |

Many observers believe that once distention and toxemia have set in only resection can save the patient. Certainly in this study resection of the bowel, even when immediate anastomosis was done, which is admittedly unwise in most instances, makes a better showing with a mortality of 73.8 per cent. than does the apparently conservative treatment of gangrenous or merely suspicious areas of the bowel wall by invagination or plication, with a mortality of 97.5 per cent. The high mortality in simple drainage of the bowel, 87.5 per cent., is after all no argument against this procedure, for it was usually employed only in those cases which were frankly hopeless from the start. The high mortality for simple herniotomy (without operation on the bowel), 57.7 per cent., is undoubtedly due to unsuspected damage of the bowel wall, and suggests that conservatism in this particular connection is rather more dangerous than apparent radicalism.

TABLE VII.

*Comparative Mortality in Relation to Procedure.*

| Procedure | Miller | Richardson | Perthes‡ | Tuttle |
|---|---|---|---|---|
| Herniotomy .............. | 57.7 | | | 25.5 |
| Drainage of bowel ........ | 87.5 | | | 76.0 |
| Resection ................ | 76.0 | 53.3 | | 68.4 |
|    with drainage of bowel | 73.8 | | 56.0 | |
| Reduction ............... | 32.7 | | | 20.0 |
| Relief obstruction only..... | 40.7 | 34.1 | 21.0 | |
|    with drainage of bowel | 56.6 | | 56.0 | |

The important fact which emerges from a study of these statistics and from those of Tuttle, Scholefield and Richardson (Table VII) is that the

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\* Of bowel.

† Of volvulus or intussusception.

‡ Quoted by Scholefield.

success of any procedure is based on its relation not only to the pathology present but to the condition of the patient. There is small point to doing a perfect operation if the patient dies on the table, as happened five times in this series. The experienced surgeon is content merely to save life, even if he does not complete his surgery; it is the tyro who must finish the job. As Horsley says, "There is such a thing as the surgeon being intoxicated with his own dexterity, so that on some occasions it overbalances his surgical judgment". Codman is right when he says that success depends more on the surgeon's mental than on his manual processes, and that surgical judgment consists in "applying a knowledge of possible expedients to a knowledge of possible pathologic combinations". To put it more colloquially, this is one condition in which Murphy's advice, "to get in quick and get out quicker", should be followed to the letter, and in which, as Bunnell says, "every manipulation is a shove nearer the grave", which latter observation holds quite as true of necessary as of unnecessary procedures.

Such matters as the location of the obstruction, the management of the distended intestines, preliminary drainage of the bowel and similar points of detail have no place in a general paper of this sort, though I cannot omit the caution that never should a gangrenous bowel, whether drained or undrained, be left within the cavity. Certain specific procedures, however, must be briefly mentioned. The short-circuiting operation suggested by Sampson Handley is a very valuable method in those instances in which the state of the bowel is uncertain or in which the patient, because of age or weakness, could not tolerate an extensive resection. On the other hand, it is time-consuming, so that it could not be used on patients in bad condition; the anastomosis is within the abdomen and the bowel is not therefore available for lavage, drainage or nutrition; and finally, the jejuno-colostomy as specifically advocated by Sampson Handley means, as pointed out by the late Dr. Parham, that the jejunal contents are returned to the colon before appreciable digestion and nutrient absorption have taken place. Enterostomy is clearly indicated in all cases in which toxemia is a factor, and Whipple pays tribute to its efficacy when he says that it has reduced the mortality at the Presbyterian Hospital by 13.2 per cent. Its advantages are evident, and the chief disadvantage, the loss of digestive fluids, is minimized by the employment of the Witzel technic, which also provides against a possible fistula and a later tedious closure. Cecostomy should be a routine procedure in malignancy of the large bowel, no matter what surgery is done. The two-stage operation is generally preferable in this condition unless the patient is unusually well fitted to withstand extensive surgery, but immediate anastomosis is almost essential when the small intestine is so involved that resection is necessary, because of the loss of digestive fluids. Wilkie's method, which was discovered accidentally, has considerable to commend it, the fluid from an upper enterostomy being allowed to flow back into the intestines through the tube of a lower enterostomy.

These, however, are all matters of specific performance. The success of surgery in intestinal obstruction is based, not upon the actual procedure adopted, providing that it stops the formation and absorption of the toxin, relieves the distention and establishes the fecal flow, but rather upon the adaptation of that procedure to the conditions present in the individual case.

It must be remembered that such pathology as intussusception and volvulus is prone to recur, and that, if the patient's condition warrants it, the faulty anatomy which is responsible for them should be rectified at the time of operation. This was vividly illustrated by a case in the present series in which, within a year, the volvulus recurred twice; the third operation terminated fatally.

It is an almost universal belief that spinal and local analgesia are to be preferred to general anæsthesia, or at least to ether anæsthesia, in all cases of intestinal obstruction because of the patient's state of shock, the blood changes, the inhibition of intestinal peristalsis, and possible post-operative vomiting. In selected cases I have no doubt that this is true, but I have long questioned the practical results of a general application of this reasoning, and this series, as will be apparent from Table VIII, quite sustains my point.

TABLE VIII.

*Mortality in Relation to Anæsthesia.*

| Type | Number cases | Per cent. cases | Mortality |
|---|---|---|---|
| None ................. | I | .3 | 100.0 |
| Local ................. | 110 | 32.1 | 78.2 |
| Spinal ................. | 33 | 9.6 | 69.7 |
| General ................ | 199 | 58.0 | 50.3 |

It is more than mere coincidence that the mortality for local analgesia should be 20 per cent. higher and the mortality for spinal analgesia should be 10 per cent. higher than the gross mortality of the whole series. It is more than mere coincidence that the mortality for local analgesia should be roughly 30 per cent. higher and the mortality for spinal analgesia roughly 20 per cent. higher than the mortality for general anæsthesia, in spite of the fact that ether, admittedly the least auspicious of the general anæsthetics, was most frequently employed. It is more than mere coincidence that the hospital which used general anæsthesia in less than 45 per cent. of its cases should have a mortality 15 per cent. higher than the hospital which used it in 91 per cent. of its cases.

Also the figures of Table IX are more than mere coincidence. Fifty-seven surgeons did the 343 cases represented in this series, five men described as A, B, C, D and E doing the greatest number. It is more than mere coincidence, I say, that the man who used the greatest amount of general anæsthesia, 57 per cent., should have the lowest mortality, 46 per cent., while the men who used the smallest amounts, 30 per cent., 25 per cent. and 29

per cent. respectively. should have the highest mortalities, 83.7 per cent., 66.6 per cent., and 70 per cent.

TABLE IX.

*Mortality in Relation to Anæsthesia and Surgeons.*

| Surgeon | Per cent. general | Mortality | Number cases done |
|---|---|---|---|
| A | 30.0 | 83.7 | 42 |
| B | 25.0 | 70.0 | 40 |
| C | 57.0 | 46.0 | 37 |
| D | 42.0 | 66.6 | 33 |
| E | 29.0 | 66.6 | 24 |

It is more than mere coincidence, as shown by Table X, that the duration of the operation should be on the average twenty-eight minutes more for local and twenty-seven minutes more for spinal analgesia than it was for general anæsthesia. A study of these particular figures in relation to deaths and cures is even more striking.

TABLE X.

*Mortality in Relation to Anæsthesia and Length of Operation.*

| Type | Duration cures— minutes | Duration deaths— minutes | Average duration— minutes |
|---|---|---|---|
| Local | 85 | 85 | 85 |
| Spinal | 76 | 95 | 84 |
| General | 52 | 62 | 57* |

These things, as I say, without meaning invidious comparisons between hospital and hospital and surgeon and surgeon, are more than mere coincidence. Prolongation of the procedure and the excessive manipulations inevitable when either spinal or local analgesia is employed are bound to exert a deleterious effect in a condition where speed and gentleness are essential, and are bound, in the end, to be worse for the patient than the results of a skilfully given anæsthetic, even when, because of the limitation of circumstances, that anæsthetic must be ether.

Moreover, as is shown by Table XI, neither local nor spinal analgesia prolongs life or defers death. Only 27.6 per cent. of the patients who

TABLE XI.

*Mortality in Relation to Anæsthesia and Time of Death.*

| Time of death | Local | Spinal | General | Total |
|---|---|---|---|---|
| Table to 12 hours | 31.4 | 39.1 | 31.0 | 32.0 |
| Within 24 hours | 46.5 | 65.2 | 49.0 | 49.8 |
| After third day | 33.7 | 8.7 | 27.0 | 27.6 |

eventually died lived beyond the third day, but only 8.7 per cent. of those who had had spinal analgesia lived beyond that time. Within the first twelve hours after operation 32 per cent. of these patients died; the figures for local analgesia and general anæsthesia are practically the same, but the figures

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* Markedly increased by fact that one patient was on table four hours.

for spinal analgesia are considerably higher. It is a frightful commentary on the deadliness of this condition and on the results of delayed surgery in it that within twelve hours after operation a third of the patients should be dead, and that only a fraction over half of them should survive at the end of twenty-four hours.

The comparative statistics of Table XII are given for what they are worth, though it is manifestly unfair to compare statistics based upon different premises, or to weigh the results of the composite work of a hospital, particularly of a public hospital, against the individual results of an expert surgeon. I think it is safe to say, however, that the higher the mortality is, the more nearly accurate it is likely to be, and that a mortality of 60 per cent. is more likely to be correct than a mortality of 30 per cent. or lower.

TABLE XII.*

*Comparative Mortality.*

| Series | Mortality | Series | Mortality |
|---|---|---|---|
| Burgess | 23.5 | McGlannan | 45.7 |
| Codman | 34.0 | Miller | 60.9 |
| Deaver & Ross | 42.0 | Richardson | 41.5 |
| Finney | 36.0 | Scudder | 60.0 |
| Guy's Hospital | 31.5 | Short | 41.0 |
| Irwin | 38.7 | Tuttle | 41.3 |
| Lynch & Draper | 25.0 | Van Beuren & Smith | 41.8 |

The exigencies of the case do not permit the rehabilitation, as we commonly understand the term, of the patient suffering from intestinal obstruction; but no matter how serious his condition, there are certain essential procedures which must never be omitted. In the first place, gastric lavage must be done and must be repeated until the fluid returns clear; otherwise, particularly if a general anæsthetic is administered and the glottic reflex is eliminated, the patient may drown in his own secretions. In the second place, normal saline solution must be given by hypodermoclysis or infusion, to restore the fluid balance and to replace the lost chlorides. After operation the treatment depends upon the necessities of the individual case, with the continued use of the stomach tube a most important factor. Blood chemistry now is essential as an index to treatment and saline solution or glucose and insulin should be employed according to the indications.

Prophylactic immunization before intestinal operation, as suggested by the results of the recent work of Hermann at the Mayo Clinic, is based on very logical reasoning, but at present, of course, is purely theoretical. This work, by the way, presents a strong argument for the two-stage resection, in that it seems to prove that the admittedly higher resistance of the patient at the second operation is due to the production of an active local peritoneal immunity by the soiling of the first operation.

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* Figures not to be accepted absolutely for comparison since they are based on different premises and include different types of cases.

The recent work of B. W. Williams with anti-gas serum, both post-operatively and as a prophylactic pre-operative measure, should also be mentioned. It is based on the theory that the severe toxemia of intestinal obstruction is due to the presence of the toxins of B. Welchii in the fecal contents above the obstruction. It cannot be denied that the symptoms of the terminal stages, at least, do suggest those of gas gangrene and, while this method is still in the experimental stage, it seems to have decided possibilities.

Certain minor considerations in this study may be of interest. Tuttle and Finney both report intestinal obstruction as somewhat more frequent in the colored than in the white race, and my own figures bear them out. At Charity Hospital (Touro does not admit colored patients) 50.8 per cent. of the cases were colored, although the relation of colored and white in the general hospital admissions for the last five years was only 44.7 to 55.3. In the entire series 63.6 per cent. of the patients were white, and the mortality for the two races was practically identical, 61 per cent. for the white and 60.8 per cent. for the colored.

One hundred ninety-one patients were male, 55.7 per cent. of the total number, and the mortality among them was 57.6 per cent., as compared with a mortality of 65.1 per cent. among the females. In both Tuttle's and Finney's series the proportion of male to female was decidedly higher than in my own series. Also Finney's theory, that the preponderance of cases in the colored race is due to the prevalence of inflammatory disease of the female pelvis, is not borne out in this study, since only 28.8 per cent. of the colored patients were women, a ratio of less than three to seven.

The ages ranged from thirteen days to ninety-two years, with nearly half of the patients between twenty and fifty. Thirty-two and four-tenths per cent. were over fifty, and I believe that this offers at least a partial explanation of the unusually high mortality for hernia in this series, since a very great number of these cases occurred in individuals over seventy, who often exhibited cardiac or renal disease in addition to the intestinal condition.

Two hundred forty-six cases, 71.7 per cent., were treated at Charity Hospital, with a mortality of 65 per cent. Twenty-eight and three-tenths per cent. were treated at Touro Infirmary, with a mortality of 50.5 per cent. The fact that Charity Hospital is a public institution which draws its population from the ignorant and indigent and from rural as well as urban districts, is undoubtedly the chief explanation of the higher mortality there, but even at that the Touro record would seem to indicate that comparative affluence and social station are no guarantee to early diagnosis and prompt treatment in intestinal obstruction.

The sixteen medical cases studied along with the surgical series resulted in a hospital mortality of 87.5 per cent. Six of these patients refused operation, and two of them were removed from the institution when nearly moribund, which explains why the hospital mortality was not 100 per cent. The duration of the illness ranged from twenty-four hours in one case to more

than seventy-two hours in eight. In two instances the diagnosis was confirmed by post-mortem, but the clinical picture was beyond dispute in all of the others, and the mere recital of the facts is a sufficient commentary on the melancholy story.

Codman, in a brief historical survey, points out that the pioneer work in intestinal obstruction was done by Fitz in 1888. At that time he collected from the literature for the preceding eight years 295 surgical and non-surgical cases, with a mortality of 69 per cent. At the Congress of American Physicians and Surgeons at which he presented his report, and at which the subject was also discussed by Senn, it was agreed that two days should be the limit of medical treatment and that after that period surgery should be considered inevitable. Our mortality today is sufficient evidence that even though our theories are different, our actions for the most part follow the plan laid down by our forefathers.

## CONCLUSIONS

1. The mortality of intestinal obstruction, while usually stated to be between 30 and 40 per cent., actually ranges between 55 and 65 per cent.

2. The chief explanation of this mortality is delay in diagnosis and treatment, and patient, medical man and surgeon are all responsible for it.

3. Intestinal obstruction has three phases, the mechanical obstruction with stoppage of the fecal current, the damage of the bowel wall with ultimate gangrene, and the production of toxins.

4. The three principal symptoms are abdominal pain, vomiting, and complete constipation, but any of these may be lacking in any case.

5. A detailed diagnosis is not essential and the seriousness of the condition warrants exploration on mere suspicion.

6. The condition of the patient rather than the procedure chosen determines the result of surgery, and it is better, generally speaking, to do too little than too much.

7. In spite of the general belief to the contrary, this series proves that from every standpoint the results are better when general anæsthesia, even ether, is employed in preference to local or spinal analgesia.

8. The principal fact which emerges from this analysis of 343 surgical cases of intestinal obstruction is that prompt operation offers the only means by which the mortality of the condition can be brought within reasonable limits.

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# A CONTRIBUTION TO THE MECHANISM OF FRACTURES AND DISLOCATIONS IN THE ELBOW REGION*

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### of Philadelphia, Pa.

The most important unexplained fact associated with the mechanism of fractures and dislocations is typical deformity, *i.e.,* the tendency of the fragments in each common fracture or dislocation to occupy a typical or usual position or deformity. Fractures of the upper extremities occur most frequently and their deformities are most typical near the large joints. As the writer sees them, dislocations are merely fractures of the skeleton at the joints with displacement of the fragments and increase the total number of fractures of the skeleton in and near the joints. It follows, therefore, that typical deformity offers its best opportunities for study near the joints. We have three large· joints in the upper extremity—wrist, elbow and shoulder—where these injuries of the skeleton are common. They are most common in the wrist region where the fall on the hand is established as the cause of the typical deformity, *i.e.,* the lower fragment is displaced backward and usually to the radial side, the upper fragment forward. The most typical fractures here usually involve the bones above the wrist-joint, the radius alone or radius and ulna, rarely the carpal bones. The writer has given much attention to hyper-abduction as the basic factor in the mechanism of fractures and dislocations in the shoulder region and as the end result at the shoulder of the effect of the fall on the hand. He has long deferred an attempt to discuss the influence of the fall on the hand in the mechanism of fractures and dislocations in the elbow region because of the special difficulties associated.

The fall on the hand has found some support in the explanation of fractures about the elbow-joint, but its influence has been invoked especially to account for posterior dislocations here. The theory has long prevailed that it tends to produce hyperextension and thus posterior dislocations of this joint. Stimson tells us that there have been offered a theory of flexion, a theory of direct displacement backward, a theory of distortion, and a theory of hyperextension and abduction. He says that it is now generally believed that the injury is habitually caused by a fall on the palm of the outstretched hand, the elbow being in complete extension and that the primary rupture of the ligaments which makes the dislocation possible is effected by hyperextension of the joint. He also says that "the mechanism or mode of production has been the subject of much controversy, largely due to the resort to hypotheses which was stimulated by the lack of definite knowledge. Few who fall are able to describe the circumstances of the fall, to say whether the arm was fully extended or partly flexed, whether the violence was received upon the hand or upon the elbow, and a preconceived theory in the mind of the surgeon is a great help to the discovery of the facts that favor it."

The writer has produced many dislocations of the elbow in the cadaver by hyperextension and has not yet produced one by any other mechanism, but this is far from proving that they are thus produced in life. The cadaver experiments upon which the theory of hyperextension is largely established were based upon the hypothesis that the force of the fall on the hand compels and tends to exaggerate extension of the elbow. About twenty-five years ago the writer * made an observation in connection with experimental work on the cadaver that interfered in his mind materially with the theory of hyperextension from the fall on the hand. He repeated the experiments of von Bruns † on the cadaver for the production of typical fractures of the head of the radius. The arm was disarticulated at the shoulder-joint, the palm placed on the ground, by the left hand the arm was held almost upright in rigid extension at the elbow, while heavy blows with a mallet in the right hand were struck on the top of the humerus until the anterior third or half of the radial head was split off vertically. Von Bruns assumed that he was thus reproducing the force of the ordinary fall on the palm of the hand. The writer believes that this assumption was correct. Probably no one has disputed it and probably no one has produced another typical fracture on the cadaver by the force of the fall on the hand. The writer obtained six typical fractures of the radial head by von Bruns' method. The vital point in this discussion depends upon whether von Bruns correctly assumed that he was reproducing the mechanism of the fall on the hand in his experiments, because if he did then it should be a simple matter to demonstrate, without hypothesis, the effect of the force of the fall on the hand upon extension or flexion of the elbow. Each fracture of the radial head obtained by the writer required many blows of the mallet on the top of the humerus and practically every blow was made with full strength of the striking arm. It was early realized that the left hand holding the cadaver humerus and arm upright was being strained uncomfortably from its effort to maintain the limb in extension at the elbow against the tendency of each blow to flex it. Efforts were made to so force the elbow into extension by the left hand that this flexion would be prevented, but the flexion or strain toward flexion always occurred. It was clear that the force of the flexion varied with the force of the blow on the top of the humerus. Because it required so many blows to produce each fracture of the radial head an attempt was made to produce the fracture by one blow. A heavy iron bar was used as a substitute for a sledge hammer, the writer holding the humerus and arm upright with both hands while an assistant struck the heavy blow on the top of the humerus. The thought had been entertained that the flexion of the elbow might be prevented when both hands were used to hold the arm upright. The violence of the flexion of the elbow following this heavy blow was so great that this experiment was not repeated. These observations on the cadaver left no doubt in the mind of the writer that the fall on the palm of the hand in life produced flexion of the elbow when the force was great enough to over-

* University of Pennsylvania Medical Bulletin, October, 1905.
† Centralblatt f. chir., vol. vii, p. 353, 1880.

come the power of the muscle contraction to prevent it, as when a gymnast turns a somersault with the aid of his hands. A light blow will scarcely demonstrate the flexion. There is nothing hypothetical about these observations and they can be confirmed or refuted by any one who cares to make the effort. A sufficient test would be the production of an experimental fracture of the radial head. This requires that the arm be disarticulated at the shoulder-joint, the palm placed on the ground, the arm held upright and rigidly straight at the elbow-joint by the left hand, while successive heavy blows are struck on the top of the humerus by a heavy mallet in the right hand. The humeral head will probably be crushed, requiring that it be sawed off before a fracture is obtained and it will be necessary to continue the blows on the new top of the humerus. In all probability, before the radial fracture is obtained, the question as to the effect of the blows on the production of flexion of the elbow-joint will be settled. In the years since these observations were first made nothing has developed to change the writer's mind on the point involved, but it has been a problem how to proceed further in applying it to



Fig 1—Left upper extremity in common attitude of fall on palm of hand Upward thrust of forearm exerted chiefly through radius because it practically alone articulates with hand In supracondylar fracture of humerus and dislocation of elbow the lower fragment is almost always pushed upward and backward behind the upper fragment as indicated by the radicle line of resistance which crossed and passes behind the humeral line of force produced by the falling body, even in A in which the elbow is in full extension This tendency is increased with increasing flexion as shown in B

the explanation of the mechanism of fractures and dislocations in the elbow region. It has not been considered important enough to go into the complicated question of why the elbow flexes from the fall on the hand but quite enough to know that it does. Evidently the anatomy of the skeleton at the elbow-joint is such that the force applied compels flexion.

One can deduce how the line of force coming down the rigidly-straight upper extremity and the line of resistance coming up from the hand on the ground meet and break the radius near the wrist-joint, the fragments being carried by the remaining force into their typical displacement, but it is a

more difficult matter to imagine how these forces act at the elbow in the presence of the complicating flexion. At the moment of impact on the palm the forearm is usually in pronation, the elbow is in extension and the posterior surface of the elbow presents postero-externally, *i.e.*, away from



Fig 2 —X ray illustrations of the left upper extremity in the same positions as the arms shown in Fig 1; A with the elbow in full extension and B with it in partial flexion. A suggests but B emphasizes more forcibly by comparison with C and D why supracondylar fracture of the humerus is more frequent than posterior dislocation of the elbow, and why mistakes in diagnosis between them were so common before the discovery of the X-ray a shows the detached fragment of the radial head knocked off and pushed downward by the fracturing force exerted through the humerus.

the body and somewhat posteriorly. (See Fig. 1.) The line of the radius which receives the chief force from the impact in ascending the forearm passes from the radial side of the forearm at the wrist (which in pronation of the forearm corresponds to the anterior surface of the elbow) to the ulnar side of the forearm at the elbow (which corresponds to the posterior surface
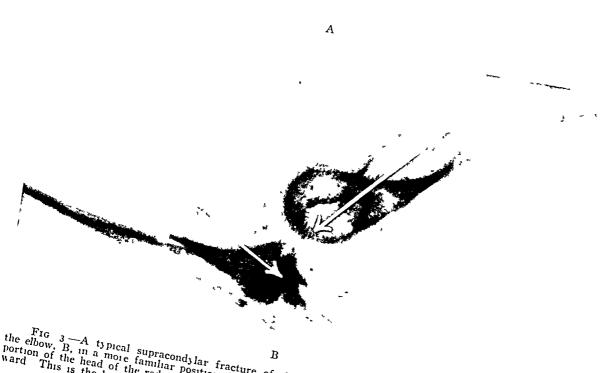
of the elbow). The line of resistance from the impact of the palm on the ground, therefore, would pass upward and backward through the radius and out of the limb posteriorly at the elbow, thus tending to drive the radial head upward and backward behind the humerus. The ulna is strongly attached to the radius partly by the ligaments at the wrist and elbow but chiefly by the strong interosseous membrane, so that the force or resistance exerted primarily through the radius is readily transmitted to the ulna, so that both bones tend to be forced upward and backward together behind the humerus at the elbow, even while the elbow is in extension. But, as already stated, it is easy to prove by the above cadaver experiment that the effect of the impact of the palm on the ground is to compel immediate secondary flexion of the elbow which then strikes the ground with the remaining unspent force. The tendency of the ground resistance acting through the radius and ulna to force these bones upward and backward behind the humerus at the elbow, at the moment of impact of the palm on the ground, is increased with increasing flexion of the elbow. We thus see how the flexion of the elbow favors the posterior displacement of the radius and ulna at this joint in a dislocation and of the lower fragment in a supracondylar fracture of the humerus. (See Fig. 2, A, B, C, and D.)

Two varieties of force can thus be seen acting to produce injuries of the skeleton in the elbow region; first, that received from the impact of the palm on the ground and continuing during the secondary flexion, and second, that from the striking of the elbow and forearm on the ground. The writer has never found it feasible to reproduce these forces on the cadaver with sufficient success to obtain any typical fracture or dislocation except the above-mentioned fractures of the radial head. He has tried, however, through X-ray and clinical evidence to trace a possible relationship between these two forces and their effects, as shown by some of the typical fractures and dislocations in the elbow region. The only injury to the skeleton in the upper extremity generally accredited to the fall on the hand is the Colles's fracture, but the writer has not found that this mechanism has ever been proved for Colles's fracture by anybody nor that any one has tried to prove it. It has merely been generally asserted and generally accepted. It probably cannot be proved except by the fact that the force of the fall on the hand can explain every phase of the typical deformity and no other force can. If that kind of evidence has been sufficient to establish the fall on the hand as the common cause of the Colles s fracture, then it should be sufficient for establishing this cause for other fractures and dislocations. Again, in the fall on the hand the main force should be exerted at the moment of the first impact, while the elbow is in extension and to a lessened degree in the immediately following flexion. The secondary striking of the elbow on the ground should do less damage because by that time much of the original force should have been spent. If this can be shown by clinical evidence to be the fact, it might be considered confirmatory evidence that the fall on the hand is the usual cause of fractures and dislocations in the elbow region. Because

*A*



*B*

Fig 3 —A typical supracondylar fracture of the humerus, A, and a posterior dislocation of the elbow, B, in a more familiar position than those shown in Fig 2, C and D. Note that the same portion of the head of the radius has been detached as in Fig 2, D, but not displaced as far downward This is the lateral view of the same dislocation as shown in Fig. 5, B.

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"few who fall are able to describe the circumstances of the fall," we cannot hope to prove the mechanism of a fracture or dislocation from the history. But the X-ray tells us positively the character of the deformity when any is present, so that we must work backward and determine the cause from the effect.

It is not intended here to offer a complete explanation of the mechanism of the various solutions of continuity in the skeleton in the region of the



A                                                    B

FIG. 4.—The most frequent fracture of the humerus here and the most frequent dislocation, not uncommonly show a posterointernal or a posteroexternal displacement of the lower fragment, which is also typical of the Colles fracture. Muscle pull is usually invoked to explain the posterior and upward displacement in the fracture but never in the dislocation, and is never called upon to explain the inward or outward displacement in either. The fall on the hand will explain every phase of these common displacements in both injuries at the elbow as in the typical Colles fracture. The inward displacement in A was associated with a typical posterior and upward displacement and that in B with a posterior dislocation of the elbow joint.

elbow-joint. The whole field is too obscure, but it is hoped that what is offered may be entitled to consideration. The tendency has been to treat fractures and dislocations as separate entities. The writer prefers to discuss the fractures and dislocations of a given region, as the elbow region, together, because he believes that they are generally due to the same force and mechanism, the skeleton giving way where it can least resist the force applied. The particular site at which the break occurs varies probably with variations in the different skeletons and in the manner in which the force exerts itself. Fractures occur most frequently near joints probably because of the effect of the joint motion in transmitting the force. Fractures are much more

common than dislocations probably because the direction of the fracturing force drives one bone directly against the other in such a way that they cannot pass by each other into the dislocated position without breaking off some obstructing portion of bone. This explains why pure dislocations of the wrist-joint almost never occur. Most fractures at the wrist occur in the radius at or immediately above this joint, and most fractures at the elbow occur in the humerus at or immediately above the elbow-joint. The expanded



A                      B
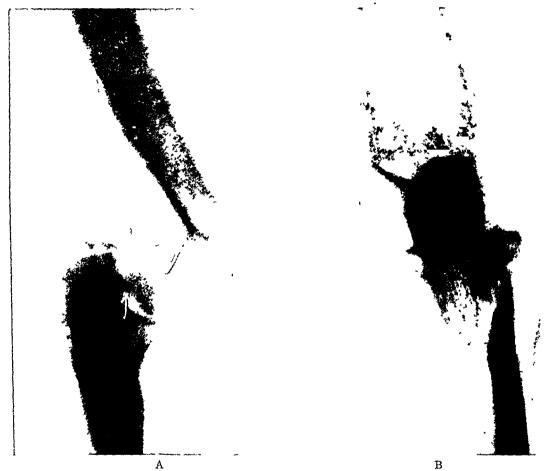
FIG. 5 —The external displacement in A was associated with the typical posterior and upward displacement of the lower fragment and the same displacement in B was associated with a posterior dislocation of the elbow (see Fig. 3 B), the two injuries occurring on opposite sides of the body.

cancellous radius is evidently less capable of resisting the force than the small and more compact carpal bones which are forced against it, and the expanded cancellous lower end of the humerus is weaker than the head of the radius and coronoid process of the ulna when they come together in the fall on the hand. In the Colles's fracture the lower fragment goes backward and upward and usually to the radial side, occasionally being displaced to the ulnar side, depending on whether the impact on the palm is received most on the thenar or hypothenar side. In the common fracture immediately above the elbow-joint, the lower fragment, as in the Colles's fracture, almost always goes upward and backward, but may go also to the radial or ulnar side, this probably depending largely upon whether the impact on the palm is received most on the thenar or hypothenar side. (See Figs. 4 and 5.)

Practically all fractures near the wrist, including those with dislocation of the wrist, show the same displacement of the fragments as the Colles's fracture, indicating that they are due to the same force, that of the fall on the hand. Most fractures of the lower end of the humerus and most dislocations of the elbow-joint have essentially the same deformities and these are not unlike that of the Colles's fracture, the lower fragment in nearly all of them passing upward and backward (see Fig. 2), and frequently to the radial or ulnar side. The dislocations of the elbow are frequently associated with fractures of the head of the radius and sometimes with fractures of the coronoid process of the ulna, but are probably much more frequently pure dislocations, *i.e.*, without associated fracture, than are dislocations of the wrist-joint. . Like the dislocations of the wrist and Colles's fractures and like the lower fragment in a supracondylar or diacondylar fracture of the humerus, the common posterior dislocations of the elbow are sometimes associated with external or internal dislocation. We thus see a very close resemblance in the deformities of all these breaks of the skeleton in the wrist and elbow regions.

The assumption of flexion, not extension, of the elbow from the force of the fall on the hand permits one to theorize on the mechanism of some of the more common breaks of the skeleton in this region. It has been demonstrated conclusively on the cadaver that the common and typical fractures of the head of the radius are produced by the first impact of the palm on the ground while the elbow is still in extension. Lotzbeck, according to Stimson, produced five fractures of the coronoid process in ten attempts on the cadaver. He fixed the elbow in a slightly flexed position by a gypsum bandage and then, striking upon the palm of the hand, produced the fractures of the coronoid process. This might be considered a reversal of the force of the fall on the hand. Varying the experiment by extending the elbow completely he succeeded in producing the fracture only once. Stimson says this fracture is very rare except as a complication of posterior dislocation of the ulna. We may have a fracture of this process and of the radial head combined. (See Fig. 6.) According to Lotzbeck's experiments the coronoid process was broken off while the elbow was in some flexion, while Stimson infers from a thorough study of the literature that it occurs almost always as a complication of dislocation of the ulna backward. If both are right we should infer that flexion of the elbow plays a very important part in the mechanism of posterior dislocation of the elbow-joint, *i.e.*, of the ulna and radius together almost always. The fractures of the coronoid process are probably very rare and usually affect the tip only, as Stimson suggests. Such fractures can be shown only by a lateral X-ray exposure and then they are usually covered by the shadow of the radial head (see Fig. 2), so that they can be easily overlooked.

In the fall on the palm, at the moment of impact with the elbow in extension, the force is received at the elbow only by the anterior half of the radial head (which is the portion commonly broken off) and by the coronoid process. (See Fig. 6.) When these two fractures occur it is seen that all bony resist-

ance to the downward thrust of the humerus from the force of the fall is removed, and, therefore, all bony resistance to the upward and backward thrust of the radius and ulna into the position of the posterior dislocation of the elbow. But while both these two fractures have been found associated with these dislocations they have not been common. Fractures of the radial head alone with these dislocations have been very much more common, but the dislocations without either fracture have seemed to be still more common. Why the dislocations occur without either fracture is probably connected in some way with the transmission of the force during the secondary flexion of the elbow-joint.

The most common fractures at the elbow are those through the condyles of the humerus, or immediately above, and almost always show posterior and upward displacement of the lower fragment which is frequently displaced also to the outer or inner side. The typical posterior displacement is favored by the direction of the fracturing force of the fall on the hand at the moment of impact, the immediately succeeding flexion



Fig. 6.—Typical fracture of head of radius with detachment of anterior portion and fracture of coronoid process of ulna. The detached fragment in each is slightly displaced downward, indicating that both were produced by the downward thrust of the humerus of the moment of impact of the palm on the ground, when the elbow was in full extension and the humeral condyles were resting on only the anterior portion of the radial head and the coronoid process. This downward displacement of the detached portion of the radial head is more marked in Fig. 2 D, and Fig. 3 B.

of the elbow increasing the tendency toward the posterior displacement. (See Figs. 1 and 2.) It is more easy to understand why this fracturing force does not permit dislocations at the wrist without fracture of the obstructing radius, than to see why it does permit posterior dislocation of the elbow without fracture of the obstructing humerus. The fracture, however, is the rule, the dislocation the exception. The humeral condyles present an almost insuperable obstacle to the passing backward and upward of the coronoid process which, consequently, in most cases, breaks off the condyles and carries the condylar fragment upward and backward with it, just as the upper row of carpal bones break off and carry upward and backward with them

the lower end of the obstructing radius. The anterior portion of the radial head strikes against the capitellum, aiding in the fracture of the condyle or being broken off itself. Not only does the coronoid process offer the chief obstruction to the humerus and play the most important part in producing the more or less transverse fracture of the humerus but is probably also responsible for the not infrequent vertical splitting of the condyles into a T-fracture. When the vertical line of fracture can be seen clearly by the X-ray it is usually seen to be almost always about opposite the tip of the coronoid process. (See Figs. 4A and 5A.) The prominent ridge on the articular surface of the olecranon begins anteriorly at the tip of the coronoid, passing backward through about the middle of the articular surface to the tip of the olecranon, and fits into the correspondingly-marked depression on the articular surface of the lower end of the humerus. This ridge therefore has the effect of a wedge tending to split the condyles into two lateral fragments through the weakest portion of the condyles. Since



FIG. 7.—Typical fracture of the olecranon. Most recent fractures and dislocations of the elbow are fixed in flexion though gravity tends to increase extension later, even with the patient supporting the weight of the forearm. When the elbow struck the ground due to the secondary flexion following the first impact of the palm on the ground, the humerus was driven downward against the olecranon at the site of the fracture in it, suggesting this as the mechanism of the fracture.

it extends through the whole joint from the tip of the coronoid to that of the olecranon, its wedge effect is probably exerted at the moment of impact and when the elbow strikes the ground from the secondary flexion of the elbow. Lateral displacement of the lower fragment seems to be frequently associated with the T-fracture, indicating that it has something to do with its mechanism. (See Figs. 4A and 5A.)

The only remaining common fracture involving the elbow-joint is the transverse fracture of the olecranon. The writer is not familiar with any recognized explanation of the mechanism of this fracture. In Figure 7 we have an X-ray illustration of a transverse fracture of the olecranon associated with a typical fracture of the head of the radius. The latter fracture has long been recognized as being due to the fall on the hand. But both occurred together and therefore were due to the same force, that of the fall on the hand. A good case can be made out experimentally for the occurrence of the radial-head fracture at the moment of impact of the palm on the ground with the elbow in extension. When the elbow gives way in flexion, secondarily to the impact on the palm, the elbow must immediately afterward strike the ground on the posterior surface of the olecranon. The X-ray shows that

the olecranon fractures usually in its narrowest and weakest portion and just under the most prominent portion of the articular surface of the humerus in contact with it, *i.e.*, just where the humerus would act most effectively as a blunt wedge driven downward into the olecranon. If some prominent object like a stone should happen to lie on the ground just under the olecranon it might be fractured more easily. Indeed, striking on such a prominent object might be necessary for the fracture.
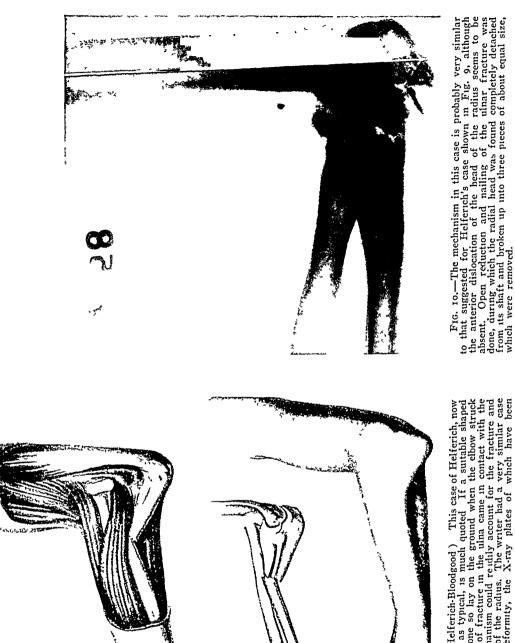
About the only remaining lesion that occurs often enough to deserve attention here is the dislocation of the head of the radius, which may be



Fig. 8.—This typical anterior dislocation of the head of the radius was never seen by the writer. The degree of extension of the elbow suggests that it is probably an old and not a recent dislocation. The secondary flexion and striking of the elbow on the ground suggested as the cause of the fracture of the olecranon in Fig. 7, might account for this dislocation if some object like a stone so lay on the ground that only the head of the radius struck on it.

anterior, external or posterior, the anterior being much the most frequent. (See Fig. 8.) It is much less frequent than fracture of the olecranon, which can scarcely be called common. The greatest violence from the fall on the hand is felt at the elbow at the moment of impact of the palm on the ground. By the time the elbow strikes the ground much of this violence has been spent, which may have something to do with the infrequency of fracture of the olecranon and dislocation of the head of the radius. This dislocation may occur alone or in conjunction with a fracture of the ulna immediately below the elbow-joint, the fracture being angulated anteriorly and the radius dislocated anteriorly. If the elbow struck on an underlying stone or other such object and this were of such a size and shape and were so situated that only the radial head received the impact on it, one can easily imagine the force driving the radial head into an anterior dislocation. The small chances of the elbow receiving so restricted a blow might explain the infrequency of this dislocation. Again, if such an object happened to so lie that the impact on it were received by the radius and ulna a little lower in the

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Fig. 10.—The mechanism in this case is probably very similar to that suggested for Helferich's case shown in Fig. 9, although the anterior dislocation of the head of the radius seems to be absent. Open reduction and nailing of the ulnar fracture was done, during which the radial head was found completely detached from its shaft and broken up into three pieces of about equal size, which were removed.



Fig. 9.—(Helferich-Bloodgood.) This case of Helferich, now well recognized as typical, is much quoted. If a suitable shaped object like a stone so lay on the ground when the elbow struck it that the site of fracture in the ulna came in contact with the stone, this mechanism could readily account for the fracture and the dislocation of the radius. The writer had a very similar case with milder deformity, the X-ray plates of which have been destroyed.

forearm, it might readily produce a fracture of the shaft of the ulna with anterior angulation at the seat of fracture and an anterior dislocation of the radial head. (See Fig. 9.) This would be the equivalent of a high fracture of both bones of the forearm, the ulna breaking at the point of impact from direct violence, the radius giving way at its joint connections from indirect violence. The relations of the articular surfaces of the ulna and humerus would make an anterior dislocation of the ulna impossible, while those of the radius to the humerus would make an anterior dislocation of the radial head easily possible. .

<div align="center">CONCLUSIONS</div>

(1) Most fractures.and dislocations in the elbow region are produced by the fall on the hand.

(2) The force of the fall on the hand tends to flex, not extend, the elbow-joint.

(3) At the moment of impact of the palm on the ground the line of force coming downward through the humerus meets the line of resistance coming upward from the ground, chiefly through the radius, at the elbow-joint, both passing out of the limb posteriorly at an angle to each other. When the effect of the meeting of these forces is to break the skeleton in or near the joint, the remaining momentum drives the two fragments in the lines of these forces.

(4) The resistance of the ground at the moment of impact tends to drive the radius and ulna upward and backward behind the humerus, this tendency being increased by the flexion of the elbow which immediately follows the impact. This mechanism accounts for the typical deformity in the most frequent fracture here, the supracondylar, and in the most frequent dislocation, the posterior, of the elbow-joint.

(5) The typical fracture of the head of the radius is produced by the impact of the palm on the ground. The typical fracture of the olecranon and the anterior dislocation of the head of the radius are produced by the force of the elbow striking the ground from the secondary flexion caused by the impact of the palm on the ground.

(6) Immediately after a fracture or a dislocation occurs in this region, the pain and irritation cause contraction of the muscles and fixation of the elbow in the position it occupied when the fracture or dislocation took place, i.e., in flexion. This is indicated by the fact that the elbow is practically always found in flexion in these injuries and that the patient supports the weight of the forearm to prevent change of this position by gravity.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD OCTOBER 1, 1928.

The President, DR. ASTLEY P. C. ASHHURST, in the Chair

DR. CALVIN M. SMYTH, JR., Recorder

DR. GEORGE W. WAGONER remarked that the differential diagnosis of destructive processes of the vertebral column is frequently difficult. He desired to report a case in which destruction of the body of the first lumbar vertebra by an invading retro-peritoneal sarcoma was. for a time, mistaken for tuberculosis of that vertebra.

A girl nine years of age was admitted August 13, 1927, in the Carnett Surgical Service at the Graduate Hospital, suffering with acute pain in the lower right abdomen. The onset of pain had been sudden and not preceded by a period of disability. An X-ray study for possible renal calculus revealed a destructive process of the body of the first lumbar vertebra, and the patient was transferred to the Orthopædic Service of Dr. DeForest P. Willard with the diagnosis of tuberculosis of the lumbar spine.

Examination elicited limitation of and pain on motion of the lumbar spine, spasm of the erector spinæ muscles, and a small kyphos over the first lumbar vertebra. Parietal tenderness and pain was present in the skin areas supplied by the eleventh and twelfth right thoracic intercostal nerves.

Extension on a Bradford frame immediately relieved the abdominal pain. The patient was then encased in a plaster jacket and, at the request of her parents, discharged on August 24 to the care of her family physician. Six days later the patient was readmitted, complaining of severe pain in both hips. Extension applied to both lower extremities gave but partial relief from pain. Examination failed to demonstrate any abnormality in either hip-joint. Symptoms of cord compression developed evidenced by a diffuse sensory envolvement and a progressive flaccid motor paralysis. On September 13 the plaster jacket was removed and a small protruding mass 'was found presenting between the eleventh and twelfth ribs on the right, two centimetres lateral to their vertebral articulations. An attempt was made to decompress the cord by aspiration of this mass. Despite the use of a large trocar and canula and an aspirating pump, no material was removed excepting several caseous plugs. The sensory and motor paralysis progressed until it became complete below the level of the twelfth thoracic cord segment. After neurological consultation it was decided to perform a laminectomy and decompress the cord; the diagnosis was Pott's paraplegia with extra-dural compression of the spinal cord.

On September 17 the spinous processes of the tenth, eleventh, and twelfth thoracic and the first lumbar vertebræ were removed. The dura mater was found to be overlain with dense masses of granulation tissue and the subarachnoid space obliterated. Removal of the granulation tissue released the dural constrictions and permitted the subarachnoid space to distend with cerebro-

spinal fluid. A slight amount of caseous pus was present in the anterior portion of the wound. Subsequent culture of this material was sterile and guinea pig inoculation was negative for tuberculosis. It was noted as an usual feature at the time of operation that several of the vertebral laminæ were necrotic. No gross tumor tissue was seen. The patient recovered consciousness on the table and was able to move her toes voluntarily and perceive stimuli applied to her lower extremities.

Following decompression the sensory and motor paralysis rapidly vanished only to reappear three weeks later. A rapidly growing, semifluctuating mass appeared at the site of operation. As this mass increased in size the paralysis increased in degree, until four weeks after the initial operation the patient had a complete paraplegia. A biopsy of the tumor was performed on November 15. At this time the mass measured seven centimetres in diameter. Microscopic examination of the tissue removed showed a round-cell sarcoma of retro-peritoneal origin.

Marked improvement in the general condition of the patient, complete obliteration of the protruding mass and a slight lessening of the paralysis followed extensive X-ray and deep therapy treatment by Dr. G. E. Pfahler. The relief following radiation, however, was temporary; pulmonary metastasis occurred and was followed by massive pleural effusions with cardiac embarrassment, generalized œdema and extreme emaciation. On May 5, 1928, the patient died.

Doctor Wagoner commented on this history as follows:—Failure by röntgenologist, surgeon and orthopædist to interpret properly the original lateral röntgenograph of the lumbar spine led to an erroneous diagnosis which was not corrected until three months after the first admission. In this röntgenograph the body of the first lumbar vertebra was shown to be partially destroyed. The remaining fragment was wedge-shaped and strongly suggested the presence of a destructive tuberculous process. But the articular cartilages were not involved as would have been the case had tuberculosis been present. Destruction of the body of a vertebra without destruction of the articular cartilages is characteristic of a sarcomatous invasion.

In addition to the misinterpretation of the röntgenograph, several features in the course of the illness of this patient stand out in retrospect as being opposed to the original diagnosis of tuberculosis of the first lumbar vertebra. (1) Inability to aspirate the small mass protruding between the eleventh and twelfth ribs posteriorly. (2) The rapid and complete flaccid paralysis. (3) The absence of a large collection of pus upon removal of the spinous processes. (4) The necrosis of the vertebral laminæ noted at time of the laminectomy.

Doctor Wagoner reported also the summary of a history extending over some thirteen years.

A negro boy, born in Philadelphia in 1908. In 1915 developed a swelling on the dorsum of the left hand at the base of the fifth phalanx which opened and became a draining wound. Three years later (1918), a second swelling appeared on the dorsum of the left hand near the wrist and also opened spontaneously. These lesions were untreated until October 19, 1920, when the patient was admitted to the dermatological clinic of Doctor Schamberg at

the Graduate Hospital. A diagnosis of tuberculosis of the skin was made and X-ray therapy instituted. After November 16, 1920, the patient failed to report for further treatment. On October 9, 1923, the patient returned to the dermatological clinic with the lesions on the dorsum of the left hand much increased in extent. Further X-ray therapy was given at regular intervals until June 18, 1925, when all the lesions were healed and the skin presented a healthy appearance.

On July 2, 1926, after an absence of a year, the patient returned, complaining of pain in the left wrist which he had first noticed several days previously. A röntgenograph of the wrist on that date showed a marked loss of bone salts with some periosteal reaction in the distal end of the left ulna, together with some opacity in the left semilunar. Actual bone destruction, however, was not demonstrable. A röntgenograph of the chest was negative for tuberculosis. The diagnosis of early tuberculosis of the left ulna and semilunar was made and the former treatment by radiation was reinstituted. Four weeks later a röntgenograph showed complete destruction of the distal diaphyseal end of the left ulna with invasion of the left trapezium. The patient was transferred to the surgical service of Dr. J. B. Carnett and on August 16, 1926, the bones of the left forearm were scraped.

The patient was transferred August 20 to the orthopædic service of Dr. DeForest P. Willard, with the diagnosis of tuberculous osteomyelitis of the left ulna. Treatment by Alpine lamp, X-ray, and immobilization was continued without arresting the rapid extension of the destructive process. A large, tense, fluctuating mass developed on the ulnar aspect of the left forearm adjacent to the wrist. This mass increased in size until on January 24, 1927, the forearm was incised and the contents of the mass evacuated and the fragments of the ulna curetted. At the time of operation the orthopædists present differed as to whether the material evacuated was tuberculous or sarcomatous. Culture of the material removed was sterile, guinea-pig inoculation was negative for tuberculosis, but a microscopic examination of the material was reported as tuberculous tissue by a pathologist not regularly on service at the hospital. The attending pathologist upon his return diagnosed the material as being typical of sarcoma.

Bone destruction continued and a new mass of necrotic tissue was formed which was evacuated on March 1, 1927. At this second operation the material was diagnosed clinically as sarcomatous. The pathologist's report of tissue removed at this operation was that of osteogenic sarcoma. On March 15, 1927, the left arm was amputated in the upper third of the humerus.

Further extension of the process with invasion of the stump of the left humerus necessitated amputation at the shoulder joint. Pulmonary metastasis, however, had occurred and these were followed by metastasis to the spine. The invasion of the spine in the lumbar and lower thoracic vertebræ resulted in complete paralysis of the lower extremities and trunk below the level of the twelfth thoracic cord segment. On February 2, 1928, the patient died.

Dr. DeForest P. Willard said that in the first case of sarcoma of the retro-peritoneal glands, which was thought to be tuberculosis of the spine, no suspicion of the true condition was had until the boggy mass appeared over the spine several months after laminectomy. Doctor Pfahler showed that the orthopædic service had been wrong in the interpretation of the film, and pointed out that destruction of the vertebral body without destruction of

the cartilaginous discs on either side of the body generally means sarcoma. If the process is tuberculous the destruction of the discs usually occurs before the bone is involved.

The second case of sarcoma of the ulna presented two very interesting problems, one, whether the boy had tuberculosis of the ulna; and second, whether the treatment for the tuberculous skin condition which he had several years before and the irritation from this treatment had anything to do with irritating the sarcomatous process. The clinical diagnosis of sarcoma was made before the laboratory reported it. The pathologist reported the mass in the arm as tuberculous, and it was not until the second operation, when it was reported as clinically sarcoma, that reëxamination of the first mass resulted in the diagnosis of sarcoma from the first and second sections. This proves that reliance on a cursory laboratory examination is unsafe. Frozen sections, in the speaker's judgment, are of no use and he believes only long serial sections have any value.


## INTESTINAL OBSTRUCTION COMPLICATING FRACTURED PELVIS

DR. ELDRIDGE L. ELIASON presented a man aged forty-four, who was admitted to Service C of the University of Pennsylvania Hospital suffering from the effects of a collision between a locomotive and the car he was driving, as a result of which he was thrown thirty or forty feet. The patient was in state of shock. The right femur was in the position characteristic of posterior dislocation at the hip. The abdomen was flat and rigid. Peristalsis was diminished, otherwise normal in its characteristics. The blood pressure was 75/50; pulse 92.

*Diagnosis.*—(1) Posterior dislocation of right femur at the hip-joint. (2) Abdominal trauma, possibly ruptured liver. (3) Mild concussion. An X-ray revealed the dislocation as well as a fracture of rami of the ischium and pubes.

Four days later the patient complained of abdominal pain. Physical examination revealed a distended abdomen and a mass in the lower right quadrant which was taken to be a retro-peritoneal hematoma resulting from the fracture of the pelvis. Some elevation of temperature persisted with some abdominal distortion, associated with increased peristalsis and difficulty in moving the bowels for a period of two weeks. At the end of six weeks the patient was discharged. Three months later at a follow-up examination he was suspected of having an intestinal obstruction and, after an X-ray study confirmed this, he was re-admitted and operation undertaken. The abdomen was opened through a low right paramedian incision and a portion of greatly distended small gut presented itself into the wound. The bowel was markedly hypertrophied, and was traced to a mass of adhesions of the small bowel in the right lower quadrant, which apparently was adherent to the lateral wall. After great difficulty the mass was freed from the adhesions. There was a rent in the mesentery of the terminal ileum through which a more proximal loop of ileum had prolapsed and, after undergoing partial volvulation, had become adherent to the lateral wall of the pelvis at the site of former fracture of the pelvis. When the adhesions were freed and the gut was entirely exposed the viscus was in such condition that a resection was deemed the best procedure. The portion between the distended ileum and the cæcum was

resected, turning in the terminal ileum just before it entered the cæcum to form a blind stump. The ileum was then anastomosed to the cæcum by an end-to-side anastomosis.

The patient made a fairly smooth recovery and was discharged cured.

Doctor Eliason remarked that the interesting feature about this case was the error in diagnosis in the beginning. He knew the patient had a mass, he knew he had a peritoneal irritation and some distention, but he was never extremely ill. The mass subsided and so decreased in size that at the time of discharge it was practically negligible. When he reported for the follow-up examination, he complained simply of indigestion, had no pain, but was losing weight and had to be extremely careful of his diet. It was difficult to convince him at this time of the necessity for X-ray study.

## PUNCTURED WOUND OF PLEURA AND PRECORDIUM

Doctor Eliason presented a youth eighteen years of age who was admitted to Service C at the University of Pennsylvania Hospital, suffering from the results of an explosion of a glass jar. The physical examination revealed the following:

1. Severe laceration and contusion of right hand, thumb all but amputated, small finger torn through all except bone, most of structure of ring finger blown away, extensive burn of right forearm. 2. Puncture wounds by glass all over the front of the right arm, chest, abdomen, thighs, face and right ear. The most important of which were: (a) Penetrating wound of chest wall just lateral to the precordium (on the left). (b) Perforating wound of right external ear. (c) Perforating wound of the left orbit, without evident involvement of the eye ball. (No wounds perforated the peritoneal cavity.) (d) Deep wound in region of the right shoulder. 3. Burns of eyes, lids, scleral conjunctivae.

The operative procedures included debridement of wounds, ligation of blood vessels, amputation of right thumb and right fourth finger, removal of foreign bodies from soft tissues and left pleural cavity.

The wound over the sternum was found to contain many particles of glass. These were removed with the infected tissue. There was exposed a probable fracture of the sternum. Closure with interrupted silk after insertion of one piece of rubber dam. Many other wounds of the chest were found, pieces of glass removed from them and the wounds thoroughly disinfected with mercurochrome. One wound in the chest wall, at about the fifth interspace, was found to penetrate below the muscles and opened into the left pleural cavity. Pulsation of the heart could be distinctly palpated and on insertion of the finger a piece of glass was found. It was removed after inserting the cholecystoscope. The lung was then distended by positive pressure and suction and the wound closed with three interrupted sutures of catgut. On attempting to remove the suction tip, resistance was encountered and in attempting to disengage its tip by traction, the apex of the heart was pulled up into the wound, due to the fact that the suction tip had entered a wound in the pericardium which had not been previously discovered. The apex was disengaged and the heart allowed to drop back into place. During these manipulations the pulse rate reached 120, but promptly dropped to 80 as soon as the sucking wound in the chest wall was closed.

The patient made a very good recovery and convalesced smoothly. An X-ray examination of the chest four days later showed no evidence of a pneumothorax, but definite evidence of a pneumo-pericardium.

## FRACTURES AND DISLOCATIONS OF THE ELBOW

DR. T. TURNER THOMAS read a paper entitled "A Contribution to the Mechanism of Fractures and Dislocations in the Elbow Region," for which see page 108.

DR. HENRY P. BROWN said that Doctor Thomas stated in order to produce the same degree of fracture as caused by the fall, he had to hammer the bone a great many times. It seemed to the speaker that any one of these hard blows with the hammer would have been as severe as the impact produced by a fall. If the impact of the one fall caused the fracture, it should have been possible to have produced the same thing with one blow of the hammer.

DR. T. TURNER THOMAS in replying to Doctor Brown's question said that he did not think the force of one blow from an ordinary wooden mallet would be as great as that from the impact of a body falling on the ground.

He had rather expected somebody to raise the question as to whether the impact of the palm on the ground would not produce hyperextension of the elbow joint in a child because the elbow of the child is so much more relaxed than that of the adult. The speaker did some experimental work recently on the cadaver of the child but could obtain only bodies of the new-born and the skeletons were so delicate that he could not apply force satisfactorily. Of course the results obtained from experimental work on the bodies of the new-born are not of much value, because the child does not fall until after he begins to walk and for a long time afterward not with enough force to produce typical results. But such results as were obtained in the cadaver arms of the new-born seemed to confirm those obtained in the adult cadavers in showing that the force of the fall on the hand would produce flexion and not extension of the elbow-joint in them.

# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 10, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

### ACUTE APPENDICITIS WITH PERITONITIS IN A YOUNG CHILD

DR. PAUL DINEEN presented a boy of twelve, who was admitted to the New York Hospital March 4, 1928. At 5:00 A. M. on the day prior to admission he was taken with sharp cramp-like abdominal pain, generalized at first over the whole abdomen and then localizing in the right lower quadrant. On admission temperature was 101.8; white blood cells 21,000 and polymorphonuclears 90 per cent. Urine negative. Past history was negative save for tonsillectomy seven years before. Abdomen showed marked tenderness and rigidity in right lower quadrant, most severe over McBurney's point. No palpable masses.

*Operation.*—McBurney incision. Peritoneum very œdematous; peritoneal cavity contained a large quantity of thick, foul, reddish-yellow fluid. The appendix was bound down by friable adhesions. Much colon smelling pus escaped from the appendix region. The appendix was large, red-black in color throughout, and so distended that it looked like a loop of small intestine with a perforation near the tip. Appendix was removed, stump not inverted as the cæcum was very friable. Wound left open. No sutures. Two cigarette drains. Culture of fluid showed *coli communis*.

*Post-Operative Course.*—Temperature fell immediately after operation but on third day it began to mount and ten days after initial operation patient was returned to operating room for drainage of pelvic abscess. During rectal examination there was an escape of a large amount of pus from the McBurney incision. Patient quickly responded favorably and was able to leave the hospital fifteen days after the first operation with a small granulating wound. One month after discharge a slight bulge was noted in the centre of the McBurney incision and there was a wide fascial separation.

June 13, 1928, three months after original operation, the boy was readmitted and the incisional hernia repaired, a small sac being found in centre of wound with adherent omentum. The peritoneal cavity showed very few adhesions. Anatomical repair. Discharged with firmly healed wound twelve days after admission.

This boy is shown in connection with the paper of the evening. An acute phlegmonous infection with a very short history. It emphasizes the severity of infections in young subjects. It brings up the question of drainage and the results. On the Second Surgical Division, Doctor Pool advocates drainage of these McBurney wounds with two cigarette drains and no sutures for any layer. Post-operative herniæ have been less since the adoption of this procedure.

Dr. John Garlock has been studying the cases of acute appendicitis in

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Doctor Pool's Division since Doctor Bancroft in 1920 reported 295 drained cases with 15 per cent. post-operative herniæ. Doctor Garlock reports the cases from January, 1921, to July, 1927. They are classified into four groups. *All drained cases.*

*A.* McBurney incision—No sutures—followed 264; Hernia 17 = 6.4 per cent.
*B.* McBurney incision—Sutured—followed 104; Hernia 16 = 11.5 per cent.
*C.* Right Rectus incision—Sutured—followed 50; Hernia 8 = 16 per cent.

*Not drained.* *D.* McBurney incision—Sutured—followed 216; Hernia 0

## TORSION OF MESENTERY

Dr. Paul Dineen presented a man, forty-two years of age, who entered the New York Hospital June 28, 1928, with a history of acute abdominal pain of twenty-four hours' duration. While eating and apparently well he was suddenly taken with acute abdominal pain, first located in the right lower quadrant and then radiating to upper abdomen. The pain was cramp-like in character, quite severe and lasted six hours, the patient vomiting during the attack. The pain disappeared for several hours and then recurred with such vigor that the patient came to the hospital. Bowels regular though they had not moved for twenty-four hours. Past history negative.

*Physical Examination.*—Abdomen moderately distended. Marked tenderness in right lower quadrant with considerable muscle rigidity of entire right rectus muscle. No tenderness elsewhere. No masses. No visible peristalsis. Rectal negative. Temperature 101.2. White blood cells 14,300; morphonuclears 84 per cent.

*Operation.*—Through a McBurney incision peritoneum was opened and a quantity of blood-stained fluid appeared. A right rectus incision was then done and on opening the peritoneum more of the blood-stained fluid was seen. A loop of constricted small intestine presented in the wound. This was found to be about two feet in length. At either end of the constricted portion the bowel was normal in appearance. The bowel in the constricted portion was dark-bluish in color but there was no evidence of gangrene. Mesentery of the collapsed loop of small intestine was twisted upon itself by a half turn. The mesentery was very friable, thick, œdematous and markedly swollen and in several places there were dark blue areas about 2 cm. in diameter. The mesentery was so friable that it was torn in several places and there was much venous oozing. Pancreas did not feel enlarged. No fat necrosis.

The appendix was found high in the upper quadrant beneath the liver and showed no sign of inflammation. After straightening out the mesentery the small intestine lost its contracted state and became normal in contour. Both incisions were closed without drainage.

*Course.*—Patient made an uneventful recovery and left the hospital in thirteen days. Barium enema shows no irregularities of the large bowel.

An unusual case of intestinal obstruction falling under the category of the volvulus type. Volvulus of the sigmoid and cæcum are not unfrequent but torsion of the mesentery of the small bowel is not so common.

In the *British Medical Journal* for June, 1927. Palit reports a case of torsion of the mesentery and states that in his review of the literature, he had found no reported cases. His case was more severe—five days obstructed,

showed a fixation of the ileum in the right lower quadrant and a twist right to left with gangrenous obstructed bowel. He was unable to relieve the bound down ileum. Patient died, but no autopsy. In the French literature he found a case reported by Pierre Delbet, "Occlusion intestinale par torsion de la totalité de l'intestin grele et de son mesenterie" in the *Bulletin et Mémoires de la Société de Chirurgie*, 1920. Delbet's case got well. He also found the ileum fixed in the right lower quadrant and the twist right to left. Delbet ascribed the condition to adhesions and bands, probably congenital folds.

## IRRADIATION AND CONSERVATIVE SURGERY IN PRIMARY INOPERABLE CARCINOMA OF THE BREAST

DOCTOR BURTON J. LEE presented a woman who, at the time of her admission, nine years and three months ago, to the Memorial Hospital in July, 1919, was sixty-five years of age.

She stated then that seven months prior to her admission a small tumor had appeared in the upper outer quadrant of the right breast. The breast slowly became larger and heavier than the left and two months prior to her admission she first noticed pain. At the same time a second soft nodule appeared in the lower outer quadrant of the breast. She had had four children and had nursed all, eighteen months each, without any complications. She had never had any serious illness.

Examination revealed a poorly nourished, anæmic woman and was without interest except for the local condition. The right breast was diffusely involved in a tumor process measuring 9 cm. in diameter. The skin was reddened and œdematous and was infiltrated with tumor tissue. The breast was movable over the chest wall. In the right axilla three enlarged firm nodes could be palpated and one in the right supraclavicular region. A chest plate made at this time was negative for evidence of pulmonary metastases.

Between July, 1919, and January, 1920, she received eighteen X-ray treatments of the low voltage type. Each treatment lasted four minutes with the following factors: 135 K.V., 7 m.amp. of current, 8½-inch spark gap, 4 mm. of aluminum filtration and an 8-inch focal skin distance.

In January, 1920, local mastectomy was decided upon because of beginning ulceration of the skin overlying the breast. January 15, 1920, under general anæsthesia this operation was performed, removing the breast alone, without any attempt at axillary dissection. A small area could not be completely closed and skin grafting was subsequently carried out.

DR. JAMES EWING reported the tumor as a compact cellular carcinoma, made up of broad groups of clear cells.

In March, 1920, the mass in the axilla measured 5 cm. in diameter and low voltage X-ray treatment was again employed over this area. In January, 1921, under novocaine anæsthesia, the axillary tumor was excised but some small shotty nodes, palpable under the pectoral muscle were not removed. Four bare tubes of radium emanation, furnishing a dosage of 200 millicurie hours were buried in this area. The pathological report on the nodes removed was carcinoma simplex. There was some delay in healing, the wound not closing completely until two months after operation.

Some thickening has persisted in the axilla which is apparently scar tissue. Since June, 1922, there has been no evidence of disease.

This patient was shown as a case successfully treated by irradiation and

conservative surgery nine years and three months since the beginning of treatment, and eight years and nine months since the mastectomy was performed.

DR. BURTON J. LEE presented a woman, who at the time of her admission to the Memorial Hospital in August, 1920, was fifty-three years of age. Her family history and past history were negative. Lactation had never been present.

In July, 1920, she noticed a small, painless lump in the upper inner quadrant of the right breast. Growth was rapid and for two weeks prior to her admission she had experienced considerable pain. Examination revealed a mass of firm consistency, 10 cm. in diameter in the lower inner quadrant of the right breast. Nipple retraction and fixation were present. The skin was smooth and glossy with definite adherence to the underlying tumor, but the breast moved easily over the chest wall. There were several large nodes in the right axilla, one large node in the left axilla, and questionable supraclavicular fulness in the right side. The chest plate was negative.

In August, 1920, the patient received a low voltage X-ray cycle of five treatments over the right breast and lymph drainage areas. The time of each treatment was six minutes and the following factors were employed: 135 K.V., 6 m.amp. of current, 8¾-inch spark gap, 3 mm. of aluminum filtration and a 10-inch focal skin distance. This cycle was repeated in September, 1920. There was a very marked effect following these treatments, the tumor becoming appreciably smaller but the axillary nodes remained unchanged. The skin showed marked irradiation changes.

In January, 1921, under novocaine anæsthesia an axillary dissection was done without removing the pectoral muscles, and many discreet shotty nodes were excised. Bare tubes were inserted in the operative field, giving a dosage of 1300 millicurie hours. The healing of the incision was somewhat delayed.

Dr. James Ewing reported upon the material removed at the operation. His report was: "Fibrosed lymph nodes. No tumor."

The right breast became quite painful and ulceration of the skin appeared. For this reason local mastectomy was decided upon and it was deemed wise at the same time to clear out the axilla again. To facilitate the procedure a portion of the large pectoral muscle was removed. Complete closure of the wound was not attempted and three weeks later skin grafting was done.

Doctor Ewing reported on the tissue removed at the second operation as follows: "The tumor is a cellular plexiform carcinoma."

There has been no further treatment since that time. There has been no local recurrence and while a small node is present in the left axilla, it has remained unchanged for several years.

The patient was shown as a case successfully treated by irradiation and conservative surgical methods eight years and two months since admission to the hospital, and seven years and seven months since operation.

DR. SEWARD ERDMAN called attention to the statement of Doctor Lee that in the first case he definitely felt a supraclavicular nodes and in the second there was questionable supraclavicular fulness. This being so, if nothing was done at the time of the axillary dissection in the way of surgical removal of the involved supraclavicular nodes how did X-ray treatment prevent metastasis? Why do cases with enlarged supraclavicular nodes practically always metastasize after breast removal? The speaker had always thought it was because at the time of operation the cancer had already gone further than the obvious involvement of the operative field. In a case treated

by radio therapy, is it claimed that this affects the distant parts of the body or only the area treated? In other words, in these women who went free from metastasis for eight and nine years after merely local or deep local radiation it would seem the cancers were operable; because the long period of cure demonstrates that from the start the cancer process was and has remained localized.

DR. ROBERT T. MORRIS asked Doctor Lee if he had any idea what proportion of cases of carcinoma of the breast will make a favorable response to radiation therapy and if there is any way of anticipating the ones that will make such response except by way of trial and error.

DR. ALEXIS V. MOSCHCOWITZ said that he has always been and is still skeptical about the actual value of irradiation before any operation for carcinoma of the breast; nor, for that matter, is he convinced of the value of irradiation after the operation. The two cases presented by Doctor Lee, however, deserve pains-taking consideration. Doctor Moschcowitz has not thus far obtained such outstanding results. He has found that after an amputation of the breast for carcinoma, when there are local recurrences or distant metastases, no amount of irradiation has been able to show one definite cure. He has gone into this subject thoroughly in collaboration with Doctor Colp and Doctor Klingenstein and has found that when cases of this nature did not die from some intercurrent disease they eventually all died from carcinoma.

Doctor Moschcowitz propounded the question whether the cases presented by Doctor Lee were cured by the operation which, in spite of the inoperability, was undertaken; or by the irradiation; or by a combination of both therapies. As a matter of argument, any one of the three may have been the possible cause.

DR. FRANK S. MATHEWS said that Doctor Lee probably classified these two cases as inoperable in the sense of not expecting a cure from operation, yet both cases were operated on after vigorous X-ray treatment and when the skin had begun to break down. He asked Doctor Lee why he decided to proceed as he had instead of first doing the operation and then instituting active radio-therapy.

DOCTOR LEE, in closing the discussion, replied to Doctor Erdman's question, asking for an explanation of the response (in these patients) of the supraclavicular nodes to irradiation, that the reason could be found in the fact that the tumor tissue was radio-sensitive. There is a wide variation in radio-sensitivity in mammary cancers, some being highly sensitive while others show little response to the use of these physical agents. In the patient in whom radium emanation seeds were implanted in the axillary nodes the satisfactory end result was due in considerable measure to the destruction of the tumor tissue in these nodes by the radium used.

There is always a possibility of error in making a clinical diagnosis of axillary node involvement. Out of one hundred cases in which the surgeon

believes there is node involvement, he will find after radical amputation, that the nodes are free in sixteen or seventeen patients. Conversely, in one hundred cases who are diagnosed as free from node involvement, examination of the axillary contents after radical surgery, one will find the disease present in these nodes in sixteen or seventeen cases.

Of the two patients presented, in the first, histologic examination proved the presence of carcinoma in the nodes. In the second, after having received a prolonged course of irradiation, only fibrosis could be made out (in the nodes), making it impossible to prove metastasis to the nodes at the time of the patient's admission to the hospital.

These two proven cases of carcinoma of the breast have been presented to show end results from the combination of radio-therapy and palliative surgery. There is good reason to believe that the heavy irradiation applied to the breast and drainage areas, some time before surgery, has been an important factor in attaining the good results.

In answer to Doctor Morris' question concerning the proportion of cases of mammary cancer that will respond to irradiation, Doctor Lee replied that he could not give the exact percentage but that a great many are radio-sensitive. Not infrequently, following adequate irradiation of a tumor 2 or 3 cm. in diameter, a marked diminution in the size of the tumor is evident and in some instances a complete disappearance of the tumor mass had occurred. The more cellular and the more malignant the growth, the more radio-sensitive it is as a rule.

Concerning Doctor Moschcowitz's remarks, Doctor Lee was aware that Doctor Moschcowitz had always been skeptical about the value of irradiation. He wondered if Doctor Moschcowitz had followed cases treated by irradiation methods over a period of years, with a continuous follow-up month by month. Only by such a method could one expect to reach reasonable conclusions as to the efficacy of irradiation.

Doctor Lee stated that he felt that radical surgery with pre- and post-operative irradiation is the best method surgeons have at present to handle primary operable cases. In primary inoperable cases (those in which the surgeon cannot expect to completely remove the disease by radical surgery) the method of choice is irradiation combined with conservative surgery, as indications require it. Radical amputation followed by irradiation yields poorer results in the primary inoperable cases than the treatment applied in these two cases.

## CHONDROMA OF CHEST WALL—RESECTION

Dr. Burton J. Lee presented an unmarried woman, thirty-eight years of age, who was first seen in February, 1924. In June, 1923, she accidentally discovered a swelling on the chest wall just above the right breast. There was never pain nor tenderness in or about this area. The breast history was negative and to the patient's recollection she had never received an injury which would account for the condition.

The findings on physical examination were negative except for the local condition. There was fulness over the middle portion of the right chest anteriorly, and 7½ cm. below the middle of the right clavicle there was a solid mass 3½ by 2¾ cm. in size. There was no tenderness on pressure, and no redness nor adherence of the overlying skin. The mass seemed to be attached to the third rib and the adjacent costo-chondral junction. An X-ray plate made at this time failed to reveal a definite process in the chest wall but only an old healed tubercular lesion in the right apex.

The patient was kept under observation and one year later the mass had grown appreciably in size, measuring 6 by 5½ cm. in diameter. Two external applications of radium had been given by Doctor Robinson of the Post Graduate Hospital, who had referred the patient.

In May, 1927, further increase in size of the tumor was noted, and at this time stereoscopic films of the chest were made by Dr. Ralph Herendeen. His report was as follows: "There is a shadow in the middle portion of the right side of the chest which is irregular in outline and of calcareous density. The bulk of it lies anterior to the costo-sternal junction of the third and fourth ribs. Considerable calcareous density is seen in the third interspace behind the costal cartilage. No rib destruction is seen and the process apparently has no connection with the bony portion of the ribs. A chronic inflammatory process, tubercular infection, calcified hematoma, or osteo-chondro sarcoma is to be considered."

At this time a decision was made to expose the mass by a surgical incision and, if feasible, remove it. July 8, 1927, the patient was operated upon in the Memorial Hospital. Under general anæsthesia an incision 20 cm. long was made, running from the second costal cartilage on the right side beyond the sternum downward and inward, following the curve of the breast at the junction with the chest wall. The pectoral muscles were cut across and turned back and when the breast was reflected outward and downward, a firm, lobulated bulky tumor was exposed. The mass, 10 cm. in diameter, seemed to arise from the third costal cartilage and rib, and extended into the second and third interspaces, posteriorly. The anterior surface was removed with a chisel, exposing the remaining portion of the tumor which encroached upon the pleural cavity, but was still extrapleural. This was then removed with a curette and a portion of the third rib resected. During the procedure the internal mammary artery was exposed, but not injured, and an area of parietal pleura, 4 cm. in diameter, was also exposed but was not opened. The operative field was irrigated with saline and the pectoral muscles closed with catgut. The skin was closed with interrupted silk and one rubber tissue drain was placed down to the pleura.

The specimen was reported on by Dr. James Ewing. "The specimen consists of one large tumor mass 9 by 9 cm. in diameter. It is irregularly lobulated. The centre is osteoid and there are soft and hard chondromatous nodules throughout. It has the gross appearance of an osteo-chondroma."

Later, microscopic examination showed it to be a simple chondroma.

The patient made an uneventful recovery and has remained well and free from any recurrence up to the present time.

The patient was reported to demonstrate the ease with which excision may be accomplished without pleural damage.

## INTESTINAL OBSTRUCTION AND MULTIPLE FÆCAL FISTULAS FOLLOWING OPERATION FOR APPENDICITIS

DR. EDWARD W. PETERSON presented a girl fourteen years of age, who in August, 1920, was operated upon at the Broad Street Hospital for acute

appendicitis. She had a stormy period following operation and on the eighteenth post-operative day she was again operated upon, the original incision reopened and a quantity of pus evacuated. Following this procedure fæcal fistulas developed and the wound never healed. The patient was in Broad Street Hospital for three months, after which she was allowed to go home.

March 2, 1921, when six and one-half years old, she was admitted to the Post-Graduate Hospital. At the time of admission she was weak, emaciated, and acutely ill, and was running a temperature ranging from 100° in the morning to 104° in the evening. There was no natural bowel movement, all fæces escaping at the site of the appendix operation. The skin about the wound was badly eroded. The urine was loaded with pus and it was found that the temperature was due to a complicating acute pyelitis.

Under appropriate treatment the temperature came down, but at this stage the child weighed only twenty-five pounds and was a most unpromising surgical prospect. Something had to be done, however, so it was decided to attempt to close the fæcal fistulas.

March 19, 1921, under ether anæsthesia, the abdomen was opened; the lower ileum found to be the seat of the obstruction. The gut was so thickened and knotted together that resection seemed to be the only rational procedure. The involved intestine, containing five fistulous openings, was resected and an end-to-end suture anastomosis was performed. Following operation the bowels moved with enema on the third day. There was a mild infection of the abdominal wound, but the patient made a good recovery and was sent to the Babies' Convalescent Home, at Sea Cliff, three weeks later, with instructions to return to the Post-Graduate Hospital in the fall for the repair of an incisional hernia, which developed after the operation.

October 1, 1921, the hernia was repaired, and the patient allowed to go home two weeks later. About a year after her discharge from the hospital she developed an acute cystitis and was taken to the New York Hospital, where an examination revealed the presence of two bladder stones, which were removed by a suprapubic operation. Since that time she has remained well and has developed into a healthy normal child of her years.

## OVARIAN CYST WITH TWISTED PEDICLE SIMULATING ACUTE APPENDICITIS

Doctor Peterson presented a girl, eight years of age, who was admitted to the Post-Graduate Hospital, January 21, 1928, as an emergency case of *acute traumatic appendicitis*. January 19 she had been kicked in the region of the right groin or hip by one of her playmates. That evening she complained of severe pain in the lower abdomen and vomited her supper. She continued to vomit all food and liquids, up to the time of her admission to the hospital. There was no bowel movement, and when enemata were given, not even flatus was passed. The temperature was normal for the first two days of the illness and only slightly elevated on the third day. Blood examination, at the time of admission, showed 13,200 leucocytes, with 80 per cent. of polymorphonuclear cells.

The physical examination was negative, except for moderate tenderness and resistance just above and to the right of the symphysis pubis. Rectal examination revealed a smooth, tense, globular mass in the mid-line and slightly to the right. Owing to the severe pain during the attack, with persistent vomiting and obstinate constipation, unaccompanied by fever, a diagnosis of ovarian cyst with twisted pedicle was made before operation.

At operation a cyst of the right ovary was found, with two complete twists of its pedicle. The appendix showed enough pathology to warrant its removal. An uneventful recovery followed.

## AFFECTIONS OF THE APPENDIX IN YOUNG CHILDREN

Dr. Edward W. Peterson read a paper with the above title for which see page 48.

Dr. Robert T. Morris asked if Doctor Peterson had examined the sympathetic lumbar ganglia for differential diagnosis; it seems that the patient had a teratoma and differential diagnosis, aside from palpation, might have been made by the fact that the second and third lumbar ganglia on both sides were hypersensitive, whereas in a chronic appendicitis with fibrosis there would have been a sensitiveness of the fused ganglion on the right side only. In an acute case, of course, there would be no sensitiveness of the lumbar sympathetic ganglia. As to the question of traumatic appendicitis, this condition does occur and it might have appeared in the case referred to by Doctor Peterson. Doctor Morris doubted if it was due to a direct blow upon the appendix, but the blow lifts the cæcum and the appendix becomes twisted upon its mesentery. Then when the cæcum returns to its normal position tenderness, pain and nausea may begin immediately and at operation the appendix will be found to be in a condition of torsion of the mesentery, due to a sequel of the blow rather than to direct injury from the blow itself. The most important question in the way of differential diagnosis was whether these ganglia of the sympathetic nervous system were sensitive on both sides of the navel, on both right and left or only on the right side, meaning chronic appendicitis.

In regard to appendicitis in young children, Doctor Morris did not hear anything in the paper about lymphatic hyperplasia which will include a definite percentage of every hundred cases in which a diagnosis is made of chronic appendicitis in children. All five kinds of chronic appendicitis may sometimes cause nausea and abdominal tenderness. These cases all present the symptom of hypersensitiveness of the fused ganglia on the right side only and also the second important diagnostic sign, chronic distention of the ascending colon, with high pitched percussion note. These two signs are all that we require for accurate differential diagnosis in cases of chronic appendicitis. Both signs are absent in acute appendicitis.

Dr. Seward Erdman remarked that there is one type of case which he felt deserved more emphasis than Doctor Peterson had given it; namely— acute mesenteric lymphadenitis—usually occurring in young children—and closely simulating acute appendicitis. He happened recently to have seen two of these cases in children, one seven and the other nine years of age, where the preliminary diagnosis was that of acute appendicitis. Careful examination showed some of the symptoms were not present but there was vomiting, slight leucocytosis and tenderness in the right side of the abdomen at and above umbilicus. In each case, although there was some question as

to the diagnosis of appendicitis, operation was demanded by the parents, and in neither case was acute appendicitis found; there was acute mesenteric lymphadenitis. In both these cases the child had a history of a slight cold preceding the symptoms of appendicitis. Several articles have been written in the last few years citing cases of this sort. This is something to be borne in mind for if these cases can be recognized operation will not be necessary, although it is safer to operate when in doubt.

Dr. NATHAN W. GREEN thought it impossible to never make a mistake in diagnosis; anyone at operation might be likely to find a fishbone in the bowel instead of a pin in the appendix. All possibilities have to be considered. There was one thing Doctor Peterson had apparently not mentioned and that was the possibility of the pain being due to an early beginning Pott's disease. It seemed to the speaker the only way to be surest of a diagnosis was to follow the plan outlined in lighter vein by Doctor Moschcowitz at one time; that is, to have the house surgeon, junior and senior internes and the attending surgeon each make a diagnosis. Out of the four one ought to be right. It seemed to Doctor Green that if one waited to make a sure diagnosis, especially one not over-familiar with this condition, one might wait too long and so do the patient more damage than by operating on an unsure but probable diagnosis and removing a normal appendix.

DOCTOR PETERSON, in closing the discussion, replied to Doctor Morris, that there was no special tenderness at "Morris's point," in the child with the ovarian cyst. The point of maximum tenderness, as he stated in his report, was just above and to the right of the pubis, almost in the mid-line. The differential points between appendicitis and pelvic disease, mentioned by Doctor Morris, did not hold good in this case.

"Lymphoid hyperplasia" was the pathological diagnosis given in two of Doctor Peterson's cases. Later the pathologist reviewed the sections in these two cases and changed the diagnosis to "healed appendicitis" in one instance, and to "chronic appendicitis" in the other.

Replying to Dr. Seward Erdman, he stated that there were several cases of mesenteric lymphadenitis in his series. The appendix was removed in these cases and showed definite pathology in every instance. Mesenteric lymphadenitis cannot be recognized with certainty before operation.

As to what special treatment he employed in cases of peritonitis, Doctor Peterson stated that he had no routine plan of treatment, except to follow in a general way the principles laid down by Murphy, Fowler, Ochsner, etc. The appendix was removed at operation, if it could be located and taken out without too much difficulty, fluid exudate was aspirated away, and drainage was provided for. Following operation it was important to introduce fluids into the system by retention enemata or the Murphy drip, and by frequent clyses or intravenous infusions, and occasionally by a blood transfusion.

Enterostomy had been employed in but two cases in the reported series and both terminated fatally. Doctor Peterson had done a jejunostomy or

enterostomy in a number of his older cases of appendicitis with peritonitis, and he felt that, in his experience, it did no good in peritonitis *per se,* and was of benefit only when mechanical intestinal obstruction was present. In the case of an older child (not included in his report) who had an attack of acute appendicitis, with rupture of an abscess into the bowel and the evacuation of a large amount of pus per rectum, followed later by a gradually developing adhesion obstruction of the intestine, a jejunostomy had proved to be a life-saving measure.

Doctor Peterson said, when operating for right inguinal hernia, it was interesting in taking the history, to go into the question of pain in the right lower abdomen, as such a large percentage of hernia patients showed definite pathological changes in the appendix. It was Doctor Peterson's rule to examine the appendix, when operating for hernia of the right side, and to remove it if it showed any evidence of disease. Mesenteric kinks or deforming adhesions, which interfered with drainage of this organ, were also indications for the prophylactic removal of the appendix.

Doctor Green had spoken of Pott's disease as being overlooked by the speaker in discussing the differential diagnosis of appendicitis. He had mentioned psoas abscess, but had failed to dilate on the early symptoms of Pott's disease.

STATED MEETING HELD OCTOBER 24, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

### STRANGULATED OBTURATOR HERNIA

DR. RICHARD W. BOLLING presented a woman of seventy-seven years, who, when seen on the morning of April 14, 1928, gave a history of persistent vomiting and obstipation for three days. The vomitus was feculent and there was only moderate abdominal distention. She was obviously suffering from intestinal obstruction, apparently involving the small intestine. The patient was removed to St. Luke's Hospital where Doctor Bolling operated on her. A right rectus incision under local anæsthesia revealed a collapsed terminal ileum. The collapsed gut was followed to the left side of the pelvis at the site of the obturator foramen, where a loop of intestine was caught in a pocket, probably between the external and internal obturator membranes. At this stage open ether was administered. The edge of the opening was well defined, sharp and apparently slightly curved. An attempt was made to dilate the opening by pressure on this edge. Then by gentle traction, first on the collapsed and then on the distended loop of intestine, a strangulated loop of ileum was delivered. This portion of intestine was not viable and twelve centimetres was resected with immediate end-to-end anastomosis. Convalescence was complicated by infection of the wound. The patient is now in excellent health with a soundly healed wound.

### PARTIAL GASTRECTOMY BY BILLROTH NO. 1 METHOD

DOCTOR BOLLING presented a man of sixty-eight years, who was admitted to St. Luke's Hospital December 9, 1927. The history was that of stomach

trouble for thirty-five years. During the past year the pain had become almost unbearable. There was an irregular, firm, freely movable mass in the epigastrium. Rontgenographic examination of the gastro-intestinal tract revealed definite evidence of defect in the pyloric region with twenty-four-hour retention. Under regional anæsthesia the pyloric portion of the stomach was



Fig 1 —After partial gastrectomy by first Billroth method  Röntgenogram following opaque meal

resected and direct union of the stomach and duodenum effected. There was an ulcerated tumor, involving the greater curvature of the pyloric region. The pathological report was a highly destructive and infiltrating adenocarcinoma of the stomach. Convalescence was uneventful and the patient was discharged four weeks after operation. He was subsequently readmitted to the medical service with a complaint of pain in the back and sense of weight in the legs. The diagnosis was metastatic carcinoma. Rontgenographic

examination of the lumbar spine showed marked osteo-arthritic changes. After a short course of radiotherapy the patient was discharged. At the present time he is much relieved and has gained twenty-five pounds since his
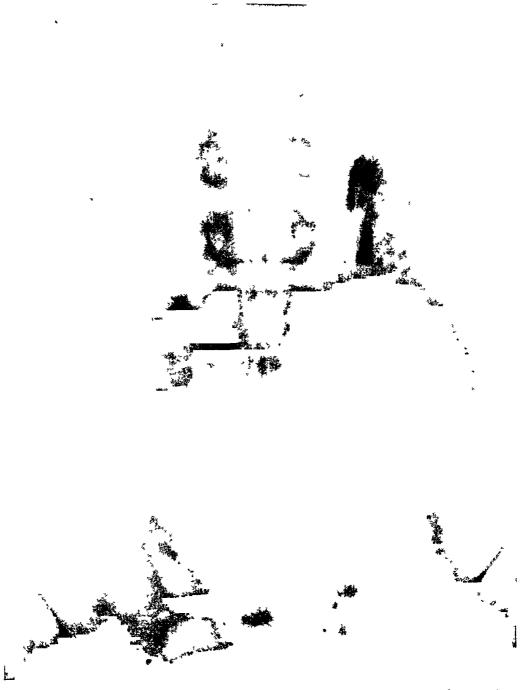


FIG 2 —Carcinoma of pyloric portion of stomach  Rontgenogram after opaque meal before operation

operation. His appetite and digestion are good and his only complaint is of pain in joints and back aggravated by changes in weather.

DOCTOR BOLLING presented also a man of fifty-two years, who was admitted to St. Luke's Hospital January 1, 1928. He had suffered with epigastric pain for fifteen years; recently there had been severe pain one and a half

hours after meals, unrelieved by food. During the past six weeks he had vomited bitter greenish fluid. He had lost ten pounds in five weeks. The patient appeared in moderately good condition. There was a hard, tender, movable mass in the epigastrium apparently connected with a dilated stomach. Examination by opaque meal showed a pyloric defect with large twenty-four-hour retention. Operation, delayed for some days on account of high
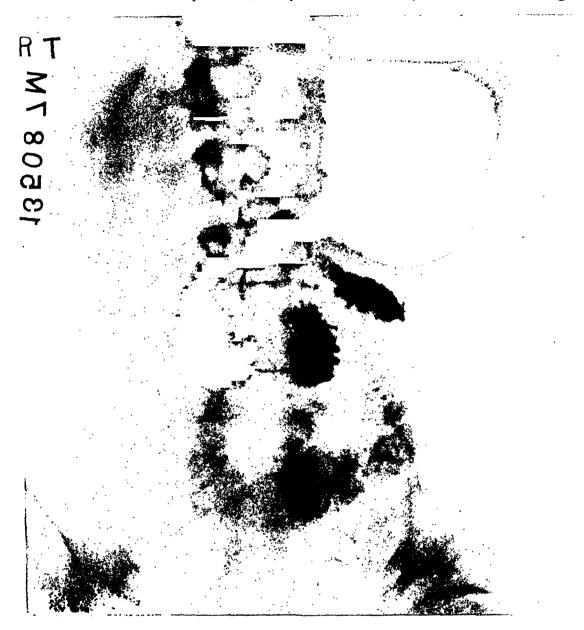


FIG. 3.—Same case as in Fig. 2 after operation. Partial gastrectomy by first Billroth method. Röntgenogram after opaque meal.

urea nitrogen retention and low phenolphthalein excretion, was undertaken January 14. A carcinoma of the pyloric region was found. Partial gastrectomy with direct union of stomach and duodenum was done. The pathological report was adenocarcinoma involving lesser curvature of the stomach just proximal to pyloric ring. Convalescence was uneventful. Patient is apparently in excellent health at the present time and has gained forty pounds in weight.

DOCTOR BOLLING presented a third patient, a man of forty-three years, who was admitted to St. Luke's Hospital May 14, 1928. His history dated

from September, 1927, and was of gaseous eructations, accompanied by burning pain in the epigastrium, unrelieved by food. He had vomited frequently and had lost thirty-two pounds in weight. He was emaciated and dehydrated. There was deep tenderness in the epigastric region but no mass could be made out. The hæmoglobin was 70 per cent. and the Wassermann



FIG 4.—Chronic ulcerative gastritis in a luetic patient. Before operation.

reaction was strongly positive. Examination with the opaque meal revealed a filling defect in the pyloric portion of the stomach with a resulting hour glass deformity. He was treated in the medical wards for one month without improvement. Doctor Bolling operated June 14, 1928. On opening the abdomen the stomach appeared smooth save at an area 5 cm. proximal to the pyloric ring where there was puckering of the anterior wall. The stomach wall felt thick but no crater could be made out. An opening was made in the stomach proximal to the thickened area and a contraction which just

Fig. 5.—Same case as in Fig. 4 after operation. Resection of pyloric portion of stomach with direct union of stomach and duodenum. Röntgenogram after opaque meal

admitted the tip of the little finger was found. A definite diagnosis could not be made at this time. The indication, however, seemed clear and the pyloric end of the stomach was resected and the cut end of the stomach was united directly to the duodenum.

*Pathological Report* by Doctor Knox. *Macroscopic.*—Specimen consists of a pylorus and distal 8 cm. of the stomach. The pylorus is normal in size and thickness. Four cm. above the pylorus there is a circular constriction in the wall of the stomach which reduces the lumen to the diameter of 1 cm. Above, the circumference of the stomach is 8 cm. and below 4.5 cm. The constriction appears to be caused by thick fibrous tissue. On either side of the stricture the mucosa is ulcerated for a distance of 2 cm. The ulcer is shallow and the edges are low. There is no gross evidence of tumor.

*Microscopic.*—Sections show a portion of ulcer which is small with necrotic edges and scarcely any evidence of hyperplasia. There is a slight dilatation of the mucous glands in a few areas. Much of the surface in the section is not ulcerated but all of it is inflamed. This mucosa is œdematous and infiltrated with eosinophiles, plasma cells and lymphocytes. The submucosa is very greatly thickened by a fairly cellular fibrous tissue in which there are localized areas of lymphoid infiltration. The muscle is fairly well preserved but shows a chronic inflammation with numerous eosinophiles, lymphocytes, and plasma cells, throughout all coats. These extend along the course of the blood vessels with some new tissue. The subserous layer is also considerably thickened. There is no marked perivascular infiltration although some of the small veins show infiltration of the adventitia and possible thickening of the wall. The lesion, however, is not a prominent one in any of the vessels. There are more lymphocytes than plasma cells. It is, therefore, impossible to designate it as a syphilitic lesion. Diagnosis, chronic ulcerative gastritis.

Convalescence was uneventful and the patient is now in good health, having gained twenty-five pounds. The Wassermann remains positive. He has not had systematic treatment since he left the hospital.

Dr. Nathan W. Green said that he had been encouraged to follow the same method in a few cases and to modify the Billroth No. 1, as he thought Doctor Bolling had done, by the Horsley method, cutting down the front of the duodenum and making a larger stoma than otherwise could be made. He has seen very good results in some of Doctor Bolling's cases and showed one here, himself, last spring that had gone about a year which had been X-rayed afterward, and which had been done by this method for carcinoma of the prepyloric segment. He saw the woman today in a follow-up and she was still doing very well and was gaining right along in weight, and had a good color. It seemed to him that this method, if it could be done as Doctor Bolling had done it, with discrimination, was a favorable method for repair after partial gastrectomy. Removing the pylorus is what Doctor Green said he had done in all his cases; he did not know whether Doctor Bolling had or not, but presumed he had. If the cases were free from tension when finished and a little omentum placed around the suture line, he thought, barring hæmorrhage into the stomach and barring a certain percentage of shock, one could be quite satisfied with the work done in cases after this manner.

Dr. Herman Fischer said that the Billroth No. 1 for some years had been his favorite method for resection of the stomach in cases of ulcer or carcinoma. He employed it, however, only in cases in which there was no tension and in which the mobilization of the duodenum was easily accomplished without getting into conflict with the biliary passages. The operation

appealed to him because it leaves the outlet of the stomach where it belongs physiologically. In Europe this operation has found more favor with surgeons than in the U. S. A. The speaker had thus operated on ten or fifteen patients until he had an experience which was startling. The patient, a young man of about twenty-four years old, had been suffering from an ulcer of the duodenum and stomach for a long time and was in consequence very much run down. A resection after Billroth No. 1 was done. The patient did very well and his recovery was smooth until the seventh day after the operation, when he suddenly collapsed. On examination an acute dilatation of the stomach was found. An immediate lavage was done, but without result. He therefore reopened the wound for exploration and found, beside a tremendous dilatation of the stomach, also a considerable dilatation of the first and second portion of the duodenum. There was absolutely no mechanical obstruction. The anastomosis was perfect. The patient did not rally and died three hours later. At the autopsy no explanation for this dilatation could be found. There have been reported several cases of acute dilatation of the stomach after Billroth No. 1 resection. One case was reported by Konjietzny who believes that this condition is caused by a paralysis of the splanchnic nerves.

Doctor Bolling, in closing the discussion, said that in his opinion the original Billroth method of partial gastric resection may be used with advantage in properly selected cases. Where the anatomical conditions are favorable, this type of operation seems to be the simplest of all methods. In his cases union of the stomach with the duodenum was effected at the greater curvature and no attempt was made to enlarge the duodenum by plastic operation. In presenting the first two patients he emphasized his belief in the value of partial resection of the stomach for carcinoma when practicable in advanced cases as a palliative measure. No one who saw these two men ten months ago and again tonight could consider them as anything but satisfactory results. The infrequency of permanent cure in such cases should not be used as an argument against partial gastrectomy.

## TENDON TRANSPLANTATION

Dr. Hugh Auchincloss presented a man, thirty-four years of age, a surgeon, who, in December, 1927, received an abrasion in the distal flexion crease of his right forefinger. Thinks he got some infection in it when he operated on an abscess. The same night it began to throb and two days later he apparently had a suppurative tenosynovitis of his digital sheath. For this he had had eighteen operations on his finger and palm. He finally came to see whether he could get anything done to give him function in his proximal interphalangeal joint.

The distal interphalangeal joint was quite ankylosed. The metacarpophalangeal joint, though it had been infected and some of the base of the proximal phalanx destroyed, had motion, though the motion was not normal inasmuch as the phalanx was somewhat subluxated. The proximal interphalangeal joint was normal. The scarred ends of the flexor tendons lay half way down the palm. There was practically no tendon distal to this and there was very little tissue available for the construction of bridges; or phalangeal annular ligaments, to keep transplanted tendon from prolapsing.

May 2, 1928, two incisions were made—one in the proximal flexion crease of the palm, the other along the outer side of the finger with a cross incision along the distal flexion crease. This left a short bridge of tissue between them in the palm. The flexor tendons were freed and the sublimis made to perforate the profundus in two places and sutured in place with fine silk. The palmaris longus tendon was exposed in the forearm and one-half of it removed and, after ligation of its proximal end by transfixion with a silk suture so that it would not split all the way, divided. This removed half of the tendon was then split its whole length into two parts except where it had been ligated off at the end. One limb of the transplant was then drawn between the sublimis
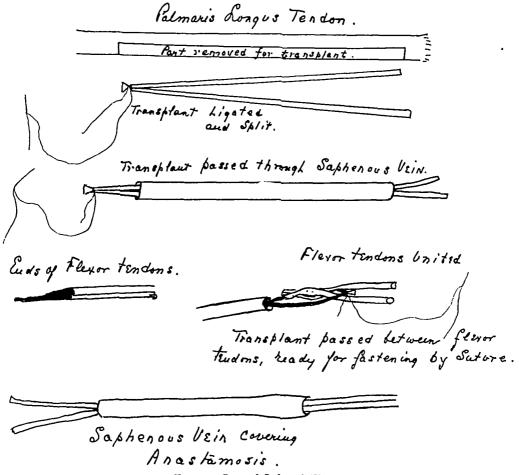


FIG. 1.—Case of Infected Finger.

and profundus above where they had been made to perforate one another and sutured in place. A piece of the internal saphenous vein was then excised, washed out with saline and the two ends of the transplant passed through it. The vein was drawn over the ends of the flexor tendon and the end of the transplant they enclosed, thus providing a smooth surface coating over the anastomosis. Transplant and vein were passed close to the bone and metacarpophalangeal joint into the finger beneath as much tissue at the base of the finger as could be saved to act as an annular ligament. The distal ends of the transplant were then laced into the base of the distal phalanx and the wound closed with very fine sutures. All traction on the transplant and weaving of the tendons were readily accomplished by means of a very delicate instrument we call a "scissor clamp" made expressly for the purpose of weaving fascial

transplants. All silk sutures passed through the tendons to their surface were passed back through their point of exit in a different direction so that practically no suture was seen on the surface of the tendons. The operation took two hours and twenty-five minutes. An Esmarch tourniquet outside three towels folded six ply was used about the arm above the elbow. The anæsthetic was ethylene oxygen. During the whole operation his respirations were deep, stertorous, vigorous and partially obstructed. At many times he became deeply cyanosed and the administration was an exceedingly difficult one. The after wound healing was quite uneventful. There was no infection nor hematoma.

On being questioned after coming out of his anæsthetic it was found his fingers and hand were anæsthetic, but that he still retained some sensation in his forearm. He had no power in his hand and forearm muscles whatever. The question arose whether any operative treatment directed toward exposing the median ulnar and musculo-spiral nerves at or above the site of the tourniquet was indicated in case hæmorrhage in and about their fibrils had taken place. After consultation with Doctors Whipple and Casamajor, who both offered an encouraging prognosis, it was decided to do nothing by operation. Seven weeks after operation he began moving his fingers slightly. Sensation had begun to return somewhat sooner.

Four months after operation the palmar incision was opened, the tendon anastomosis exposed and completely freed from adhesions in the palm and the skin sutured again. The anastomosis was smooth, glistening and even throughout. No suture could be seen. The vein had apparently become one with the tendon and aided in providing a smooth surface but not as a sheath.

He had quite regained his muscular power. He could flex his proximal interphalangeal joint but did so with difficulty, partly because of the subluxation of his metacarpophalangeal joint and partly because a slight prolapse of the transplanted tendon due to absence of good tissue for making an annular ligament caused a mechanical disadvantage. It is possible, too, that the tension of the transplant was not enough. If his proximal phalanx be held extended and fixed at the metacarpophalangeal joint his proximal interphalangeal joint motion is almost normal. He is shown because of

(1) The multiplicity of operations done.

(2) The paralysis and anæsthesia caused by the tourniquet. The speaker has used this form of tourniquet on a considerable number of cases during the past fifteen or twenty years. Never before, when towel padding has been used, has there been any trouble. He has felt that the technic provided a safe way for using such a tourniquet. Because of this case he must change his opinion. Why such a difference should have occurred in this instance is the question. That the intense venous congestion he was submitted to played a part seems plausible. If at the point where the circulation is inhibited no undue changes occur in the circulatory balance save that caused by the pressure the tissue cells in that immediate neighborhood will suffer but little damage. If, however, intense passive congestion, in every tiny venule and its larger outlets is done to return flow already slackened by a diminished arterial supply, hæmorrhage into the tissue spaces should take place and the cells be more than temporarily deprived of their circulatory mechanism due to the annihilation of the return flow conduits. The speaker has used such a tourniquet on an arm over three hours more than once and in one case over four hours with no ill effect whatever. Should any case, however, with a tourniquet applied become badly congested from the anæsthetic, it may be wise to loosen the tourniquet and leave it off entirely, or replace it for short periods at a time.

(3) The paralysis began to clear in seven weeks. The vein provided no sheath but did provide a beautifully smooth covering for the tendons at the site of anastomosis.

(4) If no annular ligaments can be fashioned one is at a great mechanical disadvantage.

(5) In estimating the function of a finger tendon transplant a deformed metacarpophalangeal joint may interfere with an otherwise good result.

(6) Would ankylosis of his metacarpophalangeal joint provide him with such good motion in his proximal interphalangeal joint as to make it worth while, or is the problem more that of tendon prolapse? Would ankylosis lessen the prolapse as well?

(7) The palmaris longus tendon is useful for tendon transplant.

(8) By weaving tendons together and burying the silk sutures an immediately stronger anastomosis can be depended on so that early motion can be begun with more assurance than when the suture alone method is used.

(9) Weaving even fine tendon strands as well as large fascial strips are greatly facilitated by the use of the scissor clamp instruments.

(10) Transplantation reconstruction of finger tendons that has sloughed or become adherent is feasible, but requires favorable conditions and niceties of technic.

DR. DEWITT STETTEN spoke of a case he presented before the Society a year ago in which he had performed a resection and reconstructive arteriorrhaphy for brachial arteriovenous aneurysm. An Esmarch bandage without an underlying towel had been applied just above the elbow and had been left in place for about fifty minutes. After the operation a flaccid paralysis of the entire forearm and hand developed somewhat as in Doctor Auchincloss' case. This was diagnosed by the neurologist as an ischemic paralysis, but because of the complete absence of sensory disturbance, the total unselected paralysis of all the muscles of the forearm and hand with no interference in the Faradic response, and the rather sudden, complete recovery without any atrophy whatsoever about three weeks after the operation, Doctor Stetten felt that this paralysis might have been of an hysterical character in spite of the apparent loss of the reflexes.

### INFLAMMATORY DISEASE OF THE MESOCOLON RESEMBLING CARCINOMA OF THE SPLENIC FLEXURE

DR. HUGH AUCHINCLOSS presented a man, twenty-eight years of age, who came to Presbyterian Hospital, July 23, 1919, with a story that he had had his appendix removed six weeks previously in another hospital, following abdominal pain and vomiting. The wound was drained. Since the operation he had had persistent pain referred to his right side, some temperature, and a fairly marked secondary anemia. Red blood cells 3,200,000, hæmoglobin 60 per cent., leucocytes 8,000, polymorphonuclears 60 per cent., lymphocytes 40 per cent. His temperature remained normal while in the hospital, his right diaphragm was slightly high but otherwise his examination was negative. One month after his discharge he felt well and was back at work.

About eighteen months later, September 9, 1921, he returned. This time he had had chilly feelings, malaise, muscle and joint pains and sore throat for three weeks and for a fortnight, sharp dragging pains in his left lumbar region that radiated to his left lower abdominal quadrant and into his left chest. His blood showed a mild anemia, red blood cells 3,600,000, hæmo-

globin 80 per cent., leucocytes 8,000, polymorphonuclears 62 per cent. His physical examination was negative save for a mass of considerable size, movable on bimanual examination but not movable with respiration, situated on the left side of his abdomen and flank. Pyelograms and barium enema showed nothing abnormal in kidney or in colon. The kidney shadow was seen just above the splenic flexure, the cæcum was dilated, but there was no sign of obstruction, and the "tumor mass is certainly not connected with the colon." Tympany was evident on colon inflation, over the mass. The urine was negative for tubercle bacilli. After ten days' observation the mass seemed smaller, very hard, not tender. Because the left ureter, on catheterization, showed a little blood, which was found in mixed urine subsequently, a hypernephroma was considered possible.
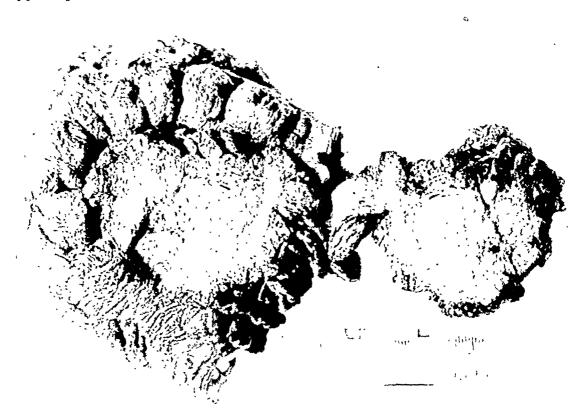


Fig. 2.—Disease of Mesocolon. Photograph of specimens removed.

May 14, 1921.—Seven and a half years ago he was operated on. First the left kidney was explored through an oblique kidney incision and found normal. The mass was found to be intraperitoneal. A left rectus incision was then made. A mass eight to ten centimetres in diameter was found in the mesocolon binding the distal part of the transverse colon to the middle of the descending colon with the splenic flexure above. It was very hard, nodular and inseparable from the two loops of colon and attached to the postero-lateral abdominal wall. Thinking it either tuberculous nodes or cancer of one of the loops of colon a resection was done, removing an appreciable amount of the lateral abdominal wall, half the transverse and most of the descending. An end-to-end anastomosis was done, by clamping with Kocher clamps, resecting with cautery close to the clamps and taking two seromuscular rows of sutures on either side of the clamps and withdrawing them just before the last sutures were taken and tied. This is practically an aseptic method of anastomosis well adapted to the large gut. In

dissecting the mass from the posterior abdominal wall, the left ureter was isolated and the mass dissected away from it. For a short distance the ureter was rather conspicuously surrounded by chronic inflammatory tissue. The wound was drained. The pathological examination showed the mass to be made up of chronic inflammatory tissue with the colon walls inseparably adherent to it. Lymph nodes were not seen in the mass though there were several enlarged in the neighborhood. No tuberculosis.

After five anxious days of colic and gas pains his gut functioned properly and in spite of distention and colon irrigations no evidence of any fæcal discharge occurred till the eighth day. This was slight and after the sixteenth day ceased entirely. On the twenty-fourth day he went home.

He returned in July of the same year, about two months later, for drainage of an abscess in his kidney wound. This wound had been made to communicate with his abdominal wound and drainage had been too restricted through that route. Since then he has remained well as far as his large intestine is concerned, but is now under observation and treatment for a small ulcer showing a crater in the first portion of his duodenum.

The reasons for presentation of this case are:

(1) Because of its diagnostic difficulties. Probably such a case cannot be diagnosed. Blood from the left ureter due to an inflammatory process in its neighborhood is always misleading.

(2) Difficulty of telling what the mass was when exposed at operation.

(3) Unusual occurrence of a large, chronic inflammatory process in a mesocolon binding the colon loops together with no demonstrable pathogenesis.

(4) *Method of end-to-end anastomosis with satisfactory function seven years later.*

(5) Similarity of the mass to carcinoma, in the gross.

Dr. Allen O. Whipple said he had seen this type of lesion which so closely resembles carcinoma. Two years ago he had a patient, a woman of sixty years of age, who was brought to the hospital with complete obstruction of the bowel. Because of the history and the fact that no bowel movement or gas had been noted for a period of six or seven days it was believed that the obstruction was rather low down and because of her poor general condition nothing was done but a cecostomy which removed the acute obstruction. At the end of seven or eight days thereafter she was given a small amount of barium and the obstruction was demonstrated to be in the region of the splenic flexure. A barium enema showed complete obstruction at that point. At operation the process causing the obstruction was quickly found and in the gross it had all the appearance of an annular scirrhous carcinoma of the splenic flexure. The patient was an obese woman and presented difficulties in making an incision on the left side. Because of the great difficulty that would have been encountered in attempting an *end-to-end anastomosis, and* because of the fact that the lesion was at the juncture of the splenic flexure and the pelvic colon, the lower end was inverted, the splenic flexure and the tumor brought out and a permanent colostomy established. That afternoon the specimen was demonstrated by the pathologist to the students as a typical case of scirrhous carcinoma of the bowel. Very surprisingly, however, no evidence of carcinoma was found in the laboratory; it was fibrous tissue and

seemed to be the remains of a diverticulum which apparently had caused this tremendous connective tissue annular ring with contraction and complete obstruction of the lumen of the bowel.

These cases, though rare, do appear. They have to be treated as carcinoma because it is inadvisable to take a piece out of the bowel in order to determine the diagnosis. The diagnosis of carcinoma is sometimes not corroborated in the laboratory and the only thing to fall back on is a statement to the family, as was done in this case, of a perfectly good prognosis as far as carcinoma is concerned.

Dr. Edwin Beer said that these inflammatory diseases of the mesocolon in his experience have usually been associated with colonic diverticulitis or with foreign body perforation from the bowel into the mesocolon, both conditions resembling each other very closely. The diagnosis in these cases is at times most difficult, especially when the inflammatory mass lies directly in front of the kidney simulating a renal neoplasm. In some of these cases a pyelogram satisfactorily rules out the kidney condition, but every once in a while, for some reason or other, a pyelogram cannot be made and pre-operatively an accurate diagnosis is impossible. In a recent case where a large mass presented in the left loin and iliac region which was ballotable like a large kidney mass, it was impossible to get a pyelogram to exclude a renal condition, and at operation the kidney was found normal but on exploring anteriorly, a fish-bone was encountered lying in some thick pus with extensive firm exudate in the mesocolon. These foreign body perforations had recently been collected at Mt. Sinai Hospital by members of its staff, and put on record. They presented a very interesting group, and though less frequent than the group of diverticulitis cases, they should always be borne in mind with these mesocolon exudates.

Dr. Frank S. Mathews referred to a man pretty well along in years who had a history of partial obstruction at the splenic flexure. Röntgenograms showed a small amount of fluid in the chest, the left diaphragm entirely fixed and immovable. He was operated on with the idea of encountering carcinoma, and at operation it was thought to be carcinoma. Because of the presumed extension to the chest resection was decided against but anastomosis between the transverse and descending colon was done. That was six or seven years ago and a few months ago the patient was reported to be in good condition. This was probably one of those inflammatory conditions often mistaken for carcinoma.

Doctor Auchincloss, in closing the discussion, said that pathological examination of the mucous membrane showed no evidence of ulceration, nor of diverticulitis. All of the mucosa was smooth. This, of course, did not rule out a former perforation or diverticulitis, but it made it most unlikely. No foreign body was found.

## NECROSIS FOLLOWING RADIOTHERAPY IN BREAST CARCINOMA

Dr. Hugh Auchincloss presented a woman, who was referred to him in April, 1918, on account of a small, firm, painless mass in the upper

outer quadrant of her right breast which she had noticed for the previous three months. X-ray and clinical examination showed no evidence of metastases elsewhere and the axillary nodes showed no clinically suspicious nodes. A very extensive fascial dissection with wide skin removal of the left breast was done, removing the pectoral muscles, rectus sheath and axilla and undermining close to the skin far and wide.

The pathological examination showed a very definite carcinoma. The axillary glands were not involved. The carcinoma cells showed differentiation and in some places acinal architecture. Her course was not unusual and she went home on her seventeenth day with a prognosis estimated more favorable than the average. She was quite lost sight of for six years when she was again located. From June 6, 1918, to April 4, 1919, she received eighty-nine radiation treatments through aluminum, bakelite, and leather filters that were in use at that time.

About seven years after the operation a small area in the scar began to show necrosis. Over the whole radiated surface were skin telangiectases. This necrotic spot enlarged to a diameter of about seven centimetres and occupied most of the upper part of the chest scar over the second and third rib. The whole area was excised and Thiersch grafted. The grafts took over the greater part of the surface. Two months later the residual granulating places were excised and grafted.

Two months later, May, 1926, the costal cartilages and portions of the second and third ribs were removed, the wound left open, and heat applied over saline dressings. The wound epithelialized from previously grafted areas without further grafting.

In 1928, two years later, the lower end of the scar of lower part of the wound began showing necrosis.

April 21, 1928, part of the fifth and sixth ribs and a considerable portion of the common costal cartilage with intercostal tissues between was removed over the cardiac area, and Thiersch's skin grafts applied over part of this pulsating wound. The grafts have grown and now, six months later, they cover the denuded area with the exception of a tiny bit of exposed cartilage below.

She is presented for the following reasons:

(1) A case of cancer of the breast who, though remaining free of her disease, is still under treatment from the results of treatment.

(2) The late appearance of the radiation dermalitis. Seven years or considerably longer time may elapse before ulceration depending somewhat on the age and nutrition of the patient. Of course many X-ray dermatitis cases show necrosis in far shorter periods, of days or weeks.
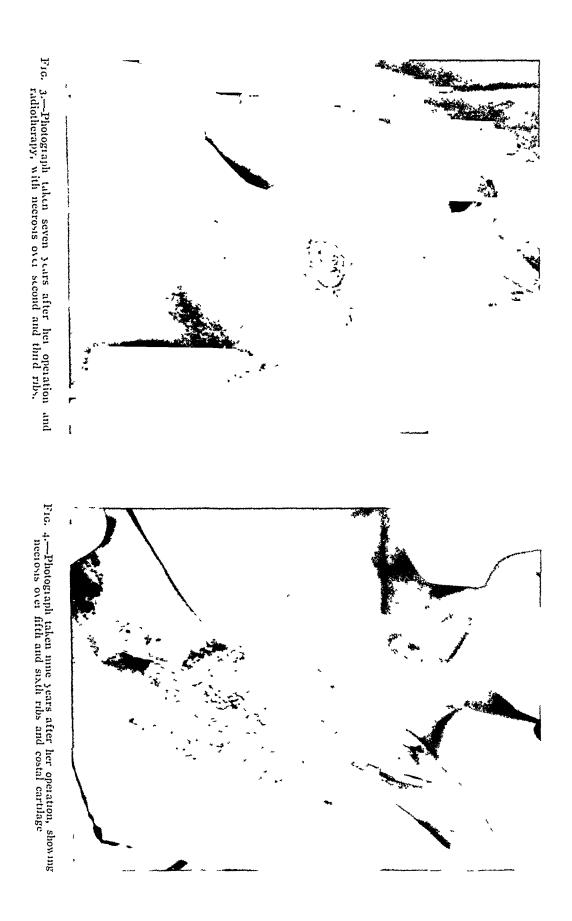
(3) The need in' this case for extensive cartilage, bone and chest wall removal before skin grafting sufficed.

(4) How X-ray exposure seems to put a reproductive quietus on the cells beneath the skin in such a case.

(5) As a warning to all advising the use of radiotherapy.

Dr. DeWitt Stetten related an experience very similar to that of Doctor Auchincloss in regard to the late effects of radiotherapy. The patient was a woman who had had an epithelioma of the chin which had been given X-ray and radium therapy at various times over a period of thirteen years. The growth then became uncontrollable and more radical surgical measures became necessary. Some time later, more than two years after the last X-ray treatment, and some fifteen years after the beginning of the treatment, the

FIG. 3.—Photograph taken seven years after her operation and radiotherapy, with necrosis over second and third ribs.



FIG. 4.—Photograph taken nine years after her operation, showing necrosis over fifth and sixth ribs and costal cartilage.

patient suddenly developed a necrosis of the inferior maxilla, very much like that resulting from phosphorus poisoning. This resulted in a complete sequestration of the entire left half of the mandible, including the coronoid and condyloid processes, and a part of the horizontal portion of the right side. He emphasized the possibility of this danger in protracted irradiation of the lower portion of the face.

DR. EDWIN BEER said that late necrosis following X-ray and radium therapy was a well-recognized clinical entity. It was of some interest to see such a late necrosis in an area in which the vascularization was so well marked as in the case described by Doctor Auchincloss. In avascularized surfaces such as are seen after radiation, one would expect occasional ulcerations. Doctor Beer himself has seen a number of late ulcerations following X-ray and radium, the latter in the bladder following radium in the cervix, and the former on the surface of the body. The radium cases had recently been discussed rather extensively before the G. U. Section of the American Medical Association in Washington in 1927. In one case where the late destruction developed from X-ray therapy, the skin over the trochanter of the femur broke down and carcinoma developed extending into the femur, producing osteomyelitis many years after exposure to therapeutic X-ray doses. In view of these late developments, it is well worth reminding the profession of these possible calamitous effects.

DOCTOR AUCHINCLOSS, in closing the discussion, said he might have given a wrong impression about the vascularity of the case. Though it appeared to have considerable vascularization because of the many telangiectases, it did not have any blood supply at all and almost all the chest wall down to the pleura had to be removed before a surface could be obtained that showed enough blood supply to make skin grafting feasible.

## CARCINOMA OF THE TRANSVERSE COLON AND CARCINOMA OF THE CÆCUM

DR. JOHN F. ERDMAN read a paper with the above title for which see page 54. In connection with his paper he presented the following patients:

CASE I.—Male, forty-four years old. When first seen was suffering from an almost complete obstruction. Has had colicky pains centring chiefly about the mid-upper abdomen. X-rays taken showed a very characteristic involvement of the mid-transverse colon.

*Operation.*—Mikulicz, on November 6, 1916. Completed December 19, 1916.

No evidences of recurrence or metastasis until January, 1924, eight years later, when he began losing ground—secondary anæmia and constant ache in the right lower quadrant. Loss of weight. *Examination.*—Palpable mass on cæcum.

*Operation* February 9, 1924.—Friedrich's operation with side-to-side anastomosis. *Pathology.*—Adenocarcinoma.

CASE II.—Endometrioma, followed by transverse carcinoma. Female, twenty-nine years old. First seen March 30, 1927. Operation three years ago for a "rupture or bloody cyst" of right groin. Operation two years ago for ovarian cyst, side not known. Now has pain in right groin at menstrual

period and has a hard growth in the groin. No examination was made of the bloody cyst removed three years ago.

*Examination* reveals irregular scar in femoral region with a very hard and exceptionally tender mass about the size of a large peanut kernel. *Advised.* —Operation if the pain became unbearable or if the lump should grow.

October 3. 1927.—Seven months later seen the second time, the growth was fully three times its original size. Now resembles a fibrosarcoma, well-fixed. Removed October 14, 1927.

*Pathological Examination.*—Recurrent adenofibroma with endometrial implantation.

*X-ray Treatment.*—No recurrence at this site up to death.

January 10. 1928.—A complete obstruction developed. X-rays showed all the evidence of carcinoma of the transverse colon.

January 12, 1928.—Mikulicz, first stage, was done. In about fourteen days a severe hæmorrhage took place following the use of an enteroteme some eight days before. Patient transfused, with recovery. Final closure of the opening in the transverse colon done February 10, 1928.

April 4, 1928.—Many metastases. Died in June. More careful search revealed endometrial tissue in the carcinomatous ovary.

CASE III.—Male, fifty-six years old, first seen April 17, 1922. Since seventeen years of age, *i.e.*, thirty-nine years, had dysentery with blood, evidently an unrecognized case of polyposis coloni. At twenty-three years of age, or thirty-three years before being seen by Doctor Erdmann, was operated upon for obstruction, a sigmoidostomy being done. Relief of his obstruction but not of his dysentery. After fifteen years of treatment by washings, etc., control enough was obtained to allow him to sleep all night.

1918.—Had a severe diarrhœa. 1919.—Fair amount of discharge from the rectum. 1920.—More discharge from the rectum. 1921.—Frequent movements with blood and mucus. 1922.—Began with muco-purulent and foul-smelling discharge, and about seven weeks before seeing the reporter in April, observed pain below the sigmoidostomy opening. Two weeks later felt something fixed below the opening with some bladder discomfort, and for three weeks he had a slight temperature.

Appendectomy done in 1916, for chronic appendix, no amœba found. Lost ten pounds in four weeks. Specimen two weeks ago of the growth reported benign papilloma. Gastro-intestinal X-ray reported negative.

*Examination,* by finger, reveals a large mass in the rectum, chiefly papilloma or polyps, with a suspicious, hard portion in the base. *Diagnosis.*— Polyptosis with secondary malignancy.

April 20, 1922.—Removal of terminal sigmoid and rectum to the anus, reimplantation of the proximal opening of the sigmoidostomy. *Pathological report.*—Adenocarcinoma.

November 11, 1922.—Gained eighteen pounds—excellent condition.

April 11, 1927.—More than four and one-half years elapsed—says he has to massage his colon for a movement. Some colics, centred mid-line, began January, 1927.

*Examination.*—Mass can be felt in transverse colon. *Diagnosis.*—Secondary carcinoma. Advised resection of, but refused and wished only a colostomy in the ascending colon.

June 30, 1927.—Gained ten pounds. Can feel with finger complete stenosis of transverse colon. Advised removal of growth—again refused.

October 14. 1927.—Fine—normal weight.

July 9, 1928.—Applies for removal of growth. At same time right colos-

tomy wound presents the appearance of a carcinomatous infiltration of the skin.

July 10, 1928.—Friedrich's operation, extending well beyond the mid-portion of the transverse colon. Liberal resection of skin about the right opening.

*Pathological Analysis.*—Scirrhous carcinoma of the transverse colon. Same type in skin about the right colostomy, metastatic. Patient sent home well in four weeks. October 3, 1928: report that about the original artificial anus (left), skin appears malignant.

CASE IV.—Male, thirty-nine years old, carcinoma of the cæcum, first seen March 7, 1927. This patient stated that up to within three months, when he began to cough, he was well. Following the coughing spell he lost thirty pounds in sixty days, jaundiced for three months, no vomiting, no bleeding, appetite fair, constipated; further than this no other history could be obtained.

*Examination.*—Nothing found as to growth. *Blood.*—High state of anæmia, hæmoglobin 35 to 40 per cent., 2,800,000 plus reds. *X-Ray* by one man —cæcal deformity; by another, gastric carcinoma, by the same man a second series eliminates the stomach and calls attention to a high-placed but normal (?) cæcum.

Exploratory operation advised but refused. *Blood.*—Hæmoglobin 45 per cent., reds 3,100,000.

April 15, 1927.—Again advised exploratory. Patient disappeared until August 1, 1927, when he returned complaining of more pain in right lower quadrant, no loss and no gain in weight.

August 12, 1927.—Again X-rayed. Nothing found. *Blood.*—Hæmoglobin 76 per cent., reds 4,150,000. *Fæces.*—Slight occult blood. Again lost until October 8, 1927, when he said he had cramps quite often, four pounds loss in weight and feels weak, no blood in stool, no vomiting. Again advised operation, but refused.

January 9, 1928.—Returned and accepted operation.

An X-ray was taken and a definite deformed cæcum found.

*Operation* January 16, 1928.—Intussusception of cæcum with the ascending colon. Large eroding carcinoma of cæcum.

*Friedrich's operation done.* Diagnosis: adenocarcinoma of cæcum, chronic lymphadenitis.

May 23, 1928.—Gained thirty-five pounds.

CASE V.—Male, sixty-three years old, carcinoma of first portion of jejunum. First seen September 16, 1927. The symptomatology was indefinite, suggesting a malignancy involving the liver. His late symptoms were constant pain in the dorsal spine and right side pointing to his upper right quadrant, loss of weight, marked. Exploration advised.

*Examination.*—Plus-plus-plus tender upper right quadrant, highly nervous, urine analysis negative. *Blood.*—Secondary anæmia. Abdomen not distended. Vomiting frequently.

*Operation.*—Evident primary lesion at the ligament of Trietz in the jejunum, with metastases in the immediate vicinity and liver. Owing to the obstruction of the jejunum a jejunostomy distal to the growth was made.

CASE VI.—Male, *seventy-five years old, carcinoma of the sigmoid with diverticulosis.* First seen July 22, 1926, with intestinal obstruction—second attack in six months. Had seen him and his X-rays eight to ten years before. Nothing but diverticulosis at that time. Operation and all clinical evidence of inoperable carcinoma of sigmoid. Permanent sigmoidostomy made. Died October 5, 1928, seventy-seven years old. Secondaries in larynx, etc.

CASE VII.—Female, fifty-six years old, carcinoma of the hepatic flexure. First seen October 31, 1927, complaining for several years of cramps which

always passed away without after result. Eight days preceding her visit she was seized with severe cramps, which have continued for the eight days. Eases up on passing gas, or enema. Lost fifteen pounds—is dieting also.

*Examination.*—Cæcum distended—no mass palpable. Succussion and metallic tinkle in cæcal zone on percussing from left toward the right of abdomen.

*X-ray.*—Obstruction about the hepatic flexure, demonstrated by barium colon enema.

*Operation* November 1, 1927.—First stage Mikulicz. *Pathological Diagnosis.*—Carcinoma of the hepatic colon. Patient discharged January 5, 1928.

CASE VIII.—Male, fifty-nine years old. Adenocarcinoma of rectum. *Complaint.*—Four to five years occasional bleeding and mucus, frequent desire to evacuate bowels; no pain, no loss of weight, constant sense of pressure in lower back.

*Examination.*—Mass palpable to finger. *Proctoscopic.*—Easily seen at seven and one-half inches.

*Operation.*—Mikulicz. *Pathology.*—Adenocarcinoma.

CASE IX.—Female, twenty-two years old. Rectal papilloma seventeen years. Finally rectal carcinoma. First seen March 6, 1911, bleeding from rectum, profusely at times, sense of weight, no pain, occasionally foreign body would protrude.

*Examination.*—Large papilloma, size of orange, on posterior wall about three inches up; another, size of prune, about four inches from the anal verge. Both easily excised. Apparently well for several years, then began to bleed again. Short proctoscope reveals multiple papillomata hanging from the two lower valves of Houston. Curetted many times in the next eight or ten years, cauterized, etc. Numerous examinations made, always innocent until January 10, 1928, reported carcinoma, wall of vagina involved. Excision by perineal route of six inches of rectum and large section of posterior vaginal wall.

CASE X.—Female, forty-five years old, perforated carcinoma of the sigmoid with abscess. First seen September 5, 1928. *Complaint.*—Distress in left side, very tender on pressure, constipation for many months, sudden pain in left flank about eight days before seeing me, no blood, no mucus by bowel observed. No X-rays taken. Temperature 101 per rectum. Lost six pounds in ten days. Red blood cells 3,500,000, hæmoglobin 64 per cent., polymorphonuclears 74 per cent.

*Operation.*—(Dense adhesions with abscess.) Removal of sigmoid and descending colon, liberating transverse to make a side-to-side anastomosis liberal drainage. Prompt recovery in two weeks.

CASE XI.—Male, forty-three years old, carcinoma, papillary, of rectum. *Complaint.*—Bleeding from bowel three years, no protrusion on defecation, considerable pain, lost fifteen pounds in eight months, weak, constant desire to evacuate bowels. No X-rays taken.

*Examination.*—Finger: reveals a tumor the size of a small egg on posterior wall about one and one-half to three inches from the anal verge. *Operation.*—Perineal resection. *Pathology.*—Papillary carcinoma of the rectum.

DR. HERMANN FISCHER remarked that metastasis in the liver is not regarded as a contraindication for operation, if the local condition is still operable. These metastases develop very slowly and he had seen many cases

live after radical operation for some time in comparative comfort. He agreed with Doctor Erdmann that primary cecostomy is very important; whether a Mikulicz or a secondary resection is done, it is a vent and safety valve of great value. Third, Doctor Fischer said, he still likes to do a perineal operation for carcinoma of the rectum. Of late there has been so much enthusiasm for the combined operation for carcinoma among surgeons that they have forgotten about the Kraske operation. The speaker was not sure whether this more extensive operation has any more value for the low carcinoma in the ampula and in the sigmoid than the old Kraske; that is, if it is properly done. Doctor Fischer said he has had very good results from the Kraske operation in carcinoma of the rectum, as far as length of time of cure is concerned. In 1918 he showed fifteen cases of carcinoma of the rectum alone so operated upon with 33 per cent. of cures longer than five years. One can remove twelve to fourteen inches of the rectum easily by the perineal route.

DR. DEWITT STETTEN said that he had always been under the impression that the proper procedure in carcinoma of the colon, particularly of the recto-sigmoid junction, in the presence of liver metastases, was a conservative operation, preferably a colostomy above the growth. He was consequently very much surprised to hear Doctor Erdmann recommend radical resection under these circumstances. The speaker had recently maintained his views in such a case in which the medical man had tried to persuade him to proceed radically, because he felt it was unjustified to subject the patient to such a severe and dangerous surgical procedure with no hope of ultimate cure. The patient, in his opinion, is just as well off, as regards comfort and duration of life, with a colostomy, which would probably be required, anyway, even if the primary tumor is radically removed. He feels the situation is entirely different from that where there is an easily removable primary growth with inoperable metastases and where there is no particular risk to the operation, for instance. as in carcinoma of the breast. He believes a simple mastectomy would be entirely justifiable to remove a large ulcerating primary growth, even if there were advanced irremovable supraclavicular lymph glands or pleuro-pulmonary metastases.

He was in entire agreement with Doctor Erdmann regarding the advisability of preliminary colostomy in most cases of carcinoma of the rectum, especially where there is already some obstruction. Dr. Frederic Kammerer had always advocated this procedure as it created an opportunity for cleansing the lower loop and thus minimized the danger of infection during the radical operation, and further permitted the usual periproctitis around the tumor to subside, so that large, fixed tumors often shrunk to half the size and became freely movable within a week or two after the colostomy. In recent years Doctor Stetten believes that the Mayo Clinic has favored this procedure.

Another point in connection with this topic which Doctor Stetten would like to emphasize is that a Mikulicz "Vorlagerung" operation is by no means an entirely safe procedure. Doctor Stetten, although he has had a considerable proportion of successes, has had three unfortunate experiences with

this operation in the past six years. In some cases, because of the position of the tumor in the lower sigmoid, because of shrinkage of the mesosigmoid, or because of metastatic involvement of the deeper mesenteric lymph glands, it is necessary to do an extensive ligation of the mesenteric vessels, usually including the inferior mesenteric artery and vein, in order to mobilize the loop sufficiently to bring it out of the abdominal cavity. The situation is frequently forced and sometimes it is absolutely impossible to control or even to gauge exactly the extent of the impairment of the viability of the gut, either of the upper or lower loop. Occasionally this extension of the gangrene is intra-abdominal in spite of every effort that can be made to prevent this occurring. Doctor Stetten's most recent case was one in which there was a definite metastatic involvement of a lymph gland at the root of the mesosigmoid and in order to get beyond this gland, it was necessary to ligate the inferior mesenteric vessels. He was quite aware of the risk he was running and made every effort to get the doubtful portion of gut well beyond the peritoneal cavity, even putting it under some tension to do so. He was not quite successful, however. The patient died within five days and a postmortem examination showed that a small area of gangrene had developed just at the intra-abdominal margin of the upper loop.

DR. RICHARD W. BOLLING said that he had been greatly impressed with the value of the multiple stage method of resection of the colon. While its widest range of usefulness is in the left half of the colon, it may be applied to any portion of the large intestine, above the rectorsigmoid. With the aid of Doctor Burford, he has recently looked over the records of the last 100 cases in which resection of the colon was done at St. Luke's Hospital. Tumors of the rectum were excluded. Of the 100 cases, in ninety-six the pathological report was carcinoma, in three lympho-sarcoma and in one, lipoma. In fifty-five cases resection was done in one stage, with immediate union of the cut ends, preceded or not by cecostomy or some other form of intestinal drainage. In this group there was an operative mortality of 26 or 47 per cent. In the remaining forty-five cases resection was accomplished in two or more stages with an operative mortality of three or slightly less than 7 per cent. Of this latter group, thirty-three were operated on after the method of Mikulicz. The contrast is striking. The multiple stage operation is, in Doctor Bolling's opinion, the method of choice in the majority of growths involving the left half of the colon. He has not had the opportunity to look up the results in the entire series. Of the nineteen cases which he operated on eight are alive; four for more than five years after operation. In fifteen of these nineteen cases resection was done in more than one stage with an operative mortality of one.

DOCTOR ERDMANN, in closing the discussion, said he was under the impression that Doctor Fischer removed the tumor as far down as possible. He had done this himself a number of times without cause for regret. In answer to Doctor Stetten he said that after one has seen a few patients in whom the growth has been left because of liver metastasis, only the establish-

ment of an artificial anus being done, one will be impressed by the complaints burning, scalding, etc., from which death seems an escape and will be willing to take a chance with radical operation in future cases. Doctor Erdmann said he operated primarily for the patient's relief. If the growth is removed something has been accomplished if there is only temporary recovery and the patient will not be subjected to the misery of an artificial anus during the duration of life. In regard to the sloughing of the intra-abdominal portion of the sigmoid or rectum, or descending colon, if the vessel is tied so as to destroy the dichotomous distribution necrosis will occur. This is unavoidable in some subjects owing to the type of veinal distribution.

## THE FUTURE OF SURGERY *

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WHEN "The Future of Surgery" was suggested to me as a subject I set about thinking of the various methods used in prophesying. I thought of the forecasts of the Weather Bureau, the exact predictions of astronomers, the extravagant prophecies made haphazard by story tellers, often curiously accurate, and the cautious guesses regarding future happenings made by the students of the past, suggestions of possibilities rather than predictions. It seemed to me that one might arrange the methods in three groups: the scientific, the romantic and the historical.

Knowledge gained by observation, arranged systematically, the painstaking study of the relations of these observations, the setting down, to be remembered, coexistences and repeated like sequences, belong to the scientific method. Making hypotheses which fit the succession of happenings, the testing of these hypotheses so as to establish them as theories and the appreciation of the rightness of these theories by their yielding confident forecasts, practical experience proving them to be sound time after time, also form part of the scientific method. A chemical reaction, the occurrence of an eclipse, are examples of prophecies fulfilled. For prophecy is a legitimate outcome of the scientific method. It implies an accurate knowledge of all the conditions and a narrow field of investigation.

In the second method, which, for want of a better name, I have called the romantic because it is not infrequently found in tales in which the incidents are remote from every-day life and experience, the prediction is but part of the fiction. If by chance there is any faintly similar occurrence years afterward, the story is looked on as prophetic. Such are the tales of Jules Verne: "Forty Thousand Leagues Under the Sea" or "Round the World in Eighty Days" or the journey to France by airship of Mr. Ponderevo in "Tono-Bungay" by H. G. Wells.

At times, however, unhampered by a story, prophecies are thrown out in pure exuberance of fancy. If the writer is trained in a branch of science and the imaginings are confined to his special field of inquiry, the prophecies are always interesting and stimulating. They seem most real, however, I

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think, to those least familiar with the particular branch of knowledge in which the writer is a specialist, for knowledge breeds scepticism, inculcates caution, makes one conscious of the difficulties of accomplishment. A forecast of Mr. I. B. S. Haldane, a reader in biochemistry in Cambridge University, is pertinent. In an essay called "Daedalus, or Science and the Future", read in 1923, after referring to an extraordinarily accurate prediction on the use of airplanes in warfare made by H. G. Wells in a book called "Anticipations", he goes on to say: "I propose in this paper to make no prophecies rasher". He then predicts the production of ectogenic children, one hundred years from now. I cannot refrain from quoting from the paper on the influence of biology on history, supposed to be written by a rather stupid under-graduate during his first term in the year 2073: "Dupont and Schwartz obtained a fresh ovary from a woman who was the victim of an aeroplane accident, and kept it living in their medium for five years. They obtained several eggs from it and fertilized them successfully, but the problem of the nutrition and support of the embryo was more difficult and was only solved in the fourth year. Now that the technic is fully developed we can take an ovary from a woman and keep it growing in a suitable fluid for as long as twenty years, producing a fresh ovum each month, of which 90 per cent. can be fertilized and the embryos grown successfully for nine months, and then brought out into the air. Schwartz never got such good results, but the news of his first success caused an unprecedented sensation throughout the entire world, for the birthrate was already less than the deathrate in most civilized countries. France was the first country to adopt ectogenesis officially, and by 1968 was producing 60,000 children annually by this method." I know of no better example of the romantic method.

The last way, the historical, does not attempt prophecy. It studies the records, the papers and the succession of text-books and attempts to make out the gradual unfolding of any branch of knowledge or any art. It inves-tigates the past and works out from it the trend of the present; it makes no bold speculative inductions, the sketch of coming time is roughly indicated, not sharply drawn. This method seems to me best suited for the study of the future of the art of surgery. I shall begin, therefore, with a retrospect of surgery. I shall attempt to find suggestions of the future by looking back on the records of the past.

In the first chapter of the tenth edition of "The Science and Art of Surgery" by Sir John Eric Erichsen, written in 1895, it is pointed out that there cannot always be fresh fields for conquest by the knife, there must be portions of the human frame that will ever remain sacred from the hands of the surgeon. "When we reflect", he writes, "that every large artery in the body up to the aorta itself has been ligated, that each of the six large articulations and many of the bones have been resected, that amputation at the shoulder or hip is a matter of ordinary occurrence, that tumors have been excised from every region of the body, that the larynx, the spleen, the kidney,

the pregnant uterus and even portions of the liver, stomach and brain have been successfully removed, we can scarcely doubt that the limits of surgery have been nearly reached."

"But if", he goes on to say, "the mechanical Art of Surgery has attained to so high a degree of perfection that we can scarcely hope for much further progress in that direction, the case is widely different with the Science. Here truly, so far from having approached the limits of our subject, we are but as yet on the threshold. For whether we regard the Science of Surgery in its relation to the essential nature, the pathology and the diagnosis of surgical disease and injuries, or whether we consider it in reference to all those circumstances which, independently of the mechanical skill of the operator, influence for good or for ill the results of his procedures, we have a field before us the extent of which it is difficult yet to estimate."

The first part of this prediction has been often quoted in papers on the "Future of Surgery" to show how wrong Erichsen was. Yet I venture to quote it in its entirety as essentially correct for the thirty-three years that have passed since it was written. The third of a century, or a generation, about the time that I have been able personally to follow the development of surgery (the ninth edition was one of the text-books I used when a student in medicine) has again shown that the advance of science has produced the advance in surgery. Erichsen's qualifications for making such a statement on surgery were unusual. The first edition of his book appeared in 1853. He writes that it represents the substance of lectures on surgery delivered at University College since his appointment to the Chair of Surgery in that institution. He was appointed in 1850 and Lister was his house surgeon the following year. On December 22, 1846, he had been present at the first public operations on patients anæsthetized by ether. Lister saw the same operation as a first year student. By the time the eighth edition appeared, thirty-one years later, in 1884, he could write of the antiseptic methods introduced by Lister and "founded on the experimental researches of Pasteur." He was writing and teaching surgery when two of the discoveries that have most influenced it took place.

Erichsen distinguished sharply between the art and the science of surgery. I think this has led to some misunderstanding. Neither the past of surgery nor the future can be discussed without an attempt to make clear the relation of allied sciences to surgery and to discuss whether one can even speak properly of the science of surgery. During the forty years that the various editions of his book were used as a text-book in England and America, it was published under the title of "The Art and Science of Surgery". He had always in mind that there was something more in surgery than manual dexterity. He writes: "a great surgical operation, in its conception, performance and its completion, tests the operator's medical knowledge as much as and in as varied a manner as it taxes his manual skill." By the Science of Surgery he evidently meant what he rightly refers to in this sentence as medical knowledge, the notions of the etiology, exact notions not only of the

morbid anatomy and the morbid physiology of the condition but of the patient he is treating. Surgery, if you will, is an applied science. Erichsen, himself, in one place calls it a scientific art, but for most of us it is essentially a practice, a way of treating disease. When Iago asks Cassio if he is hurt and Cassio replies: "Aye, past all surgery," he is thinking, not of any systematized knowledge, but that he is so badly injured that he cannot be repaired, he is broken past mending, even if it is only his reputation he is thinking of. Since Shakespeare's time it has always been used in this sense. In the large Oxford dictionary the only definition of surgery is "the art or practice of treating injuries, deformities and disease by manual measures." To be sure there is an element of science in every art. But have we not all a vague understanding that science has to do with knowing and art with doing?

The surgeon, if you will, is an artisan, a handicraftman. His handicraft is influenced largely by classified and systematized knowledge, verified by repeated clinical observations and checked by research and experiment in a variety of closely allied subjects, but outside this he is dealing with things incomplete and uncertain, things he learns only by experience. He belongs in a group with the farmer, the carpenter, the builder and the navigator.

One skilled in guiding vessels over the seas into distant harbors determines his ship's position by geometry and nautical astronomy, but seamanship is necessary. He must have an eye to tides and variable winds, floating icebergs and shifting sandbars. Thus it is with the surgeon: he must practice his art under changing circumstances and in conditioning environments often imperfectly understood. The various sciences he uses are shared with the medical practitioner, just as the navigator shares applied geometry with the surveyor and the builder. It seems to me, in studying surgery in the past or in attempting to determine its trends in the present, it is a mistake to divide it into an art and a science. It is clearer to think of it as a practice and to speak of the technic and the fields with which it is occupied. Surgery is concerned with a group of disorders which the state of medical knowledge at any given time, believes to be most advantageously treated by manual measures.

I shall therefore consider the technic of surgery and the field of surgery, and attempt to show how they have been modified since Erichsen's time and how we may expect them to be modified with the understanding that the two go hand in hand.

Every art has a technic, a mode of execution, a special skill in working out the desired end and this special skill is dependent largely on the congenital aptitude for the work in hand, on apprenticeship and on opportunity.

Each one of us is born with slight differences in makeup, our natural propensity varies our ability to do things. A man is born with a hand that does things easily and skillfully, just as he may be born with an ear and a brain that can distinguish fractional differences in wave lengths of sound, and a man may come into the world with unusually delicate muscular sense, that sense which registers in the brain the stress or strain which is being

exerted. There are wide variations in visual memory. If two boys without training are set down before a clock and asked to take it down and set it up, one may do it far more readily than the other. Both will probably easily take it apart, but one has seen in his mind's eye so accurately the relation of each part as it was taken down that he can put it together again without difficulty. The faculty of acting well under unexpected circumstances, a certain coolness and absence of flutter and agitation when acting in an emergency, seems to be more marked in some children than in others. A certain rapid and accurate appreciation of the relative value and probable sequence of things, an intellectual grasp of the group of all the attendant circumstances, what we call sagacity or mother wit, is far more marked in some than in others and seems altogether independent of cleverness in books and a facility in solving set problems.

Deftness, muscular sense, eye memory, self-possession, presence of mind and common sense, are all qualities especially valuable to the surgeon.

We are concerned with whether or not they are all to be more marked in the future and whether, as we look back, we find any evidence that these qualities were less developed. The whole trend of modern teaching points in one direction. Paleontologists, anthropologists and historians give one answer. They all show that biological development has nearly stopped or is too slow to be appreciated in the historical period. Looking back on the long stretches of time since man first began to make tools, makes us realize that Hippocrates and Galen are our contemporaries. We have not the slightest reason for thinking that children born today or that will be born tomorrow are defter, better natural workmen than those in Athens five hundred years before Christ, or the goldsmiths, architects, sculptors, painters, workers in stone and carvers of wood living in Florence in the fifteenth century.

Aside from inborn fitness for any art or craft, there is the question of training and opportunity. The natural variations in the characteristics we have enumerated give us such a wide range in the combination of qualities that the average man is within the range of a skilled worker, provided he serves an apprenticeship and provided occasion is given for the carrying out of his craft. One might make a rough guess that 5 per cent. of the house surgeons that one remembers were congenitally unfit for the task and that 5 per cent. have shown such an unusual natural endowment that, with practice and opportunity, they were generally recognized as destined to be outstanding figures, but that 90 per cent. have sufficient natural capacity to become competent surgeons with the training and the chance. The ordinary builder, plumber, carpenter, and painter that one sees is good at his trade, not because he is exceptionally gifted, but because he is exceptionally trained and has unusual opportunity to work at his trade. As Emerson said in his essay on "Power", practice is nine-tenths. Initiatory training, the setting to work assisting and carrying out under direction gradually more and more difficult tasks, doing over and over again the various technical procedures till they sink into the subconscious and become reflexes, and an opportunity to work

day after day, are indispensable in the attainment of skill in any of the arts and crafts. If we have little reason to believe in a change in natural capacity, we have convincing proof that there has been a gradual increase, both in the opportunity to do surgery and in the opportunity to learn its art as an apprentice. The most casual glance at hospital records shows an extraordinary increase in the number of operations during the last thirty-three years. The costly and elaborate technic necessary in modern surgery is gradually throwing all surgical work into hospitals and clinics. More and more, the surgeon will operate where he does it to the greatest advantage. The ease of communication, the drift of the populations toward large centres, are tending and will continue to tend to take the sick to the surgeon rather than the surgeon to the sick. This tendency has acted and will act to give not only increasing opportunity to do surgery but to learn surgery. There is every reason to suppose that surgery, throughout the world, will surely and slowly advance technically. The widespread and growing disposition of groups of workers, from different parts of the same country and from far off countries, to watch surgical procedures, not in amphitheatres as formerly, but over the shoulder of the operator, makes for uniformity. The surgeon of the out-of-the-way places (and the time seems approaching when there will be no out-of-the-way places), sees and copies the work done in the great clinics and centres of surgical activities. In the future one would expect not so much a development of a few with extraordinary facility, but a great increase in the number of those who are considered highly skilled.

By 1895, the introduction of anæsthesia and the knowledge of the relation of microörganisms to wound infection had made surgery relatively painless and relatively safe. The knowledge of anatomy had advanced to a stage when the naked eye appearance of the various structures and organs had been accurately described and correctly represented. The various operative procedures worked out on the cadaver for the ligation of vessels, amputations and disarticulations, are described accurately in *Faraboeuf's Manual*, published in 1895. The completion of this Operative Surgery by the prosectors of Paris, published in 1904, including operations on the various organs, gives a description of most of the procedures in use today. Forty-two years ago Billroth reported fourteen cases of the excision of the pylorus and modifications of these procedures are still used. The open treatment for fractures and the introduction of plates for holding the fragments was discussed and warmly advocated in the Ninth Congress of Surgeons, in Paris, in 1895. Twenty-eight years ago a report from Krönlein's Clinic in Zurich on the end results of operative treatment of twenty cases of exophthalmic goitre, including ligation of the vessels, resection and enucleation, was published. The patients had been operated on between the years 1888 and 1900. In 1895, Ssabanejew performed the first embolectomy, removing an embolus from the femoral artery. By 1910, portions of the hypophysis had been removed fourteen times. All these reports, however, show a far higher mortality than at present. The thyroidectomies showed a mortality of 8.6 per cent. The

mortality in nephrectomy for tuberculosis was over 30 per cent.; today it is 2 per cent. Billroth reported eight deaths and six recoveries in pylorectomy; three years ago Balfour reported forty-six partial gastrectomies with one death. We could go on multiplying examples.

The advance has not been in new procedures but in perfecting old procedures, in refinement of technic and in lessened mortality. With a gradual increase in the number of patients, with increased opportunity to perform operations, there has developed increased skill and, with increased skill, lessened mortality. With lessened mortality more patients have come to the surgeon. A favorable circle has been created during the last thirty years.

Another factor, aside from relative safety and relative painlessness, that has brought about the increase in surgery, is increased accuracy in diagnosis. The surgeon is essentially concerned with what he can see and feel. The visible field has been largely increased, especially since 1895. In days when there was uncertainty whether or not a stone that was supposed to be causing symptoms would be found, it was but natural that there should be reluctance to submit to attempts to remove it. Three hundred and fifty years ago, Montaigne was complaining that "a gentleman in Paris was not long since cut for the stone, in whose bladder they found no more stone than in his hand."

Toward the end of 1895 the discovery of a physicist, Röntgen, and the developments arising from this discovery, introduced into medicine a most valuable diagnostic method.

In 1879, Edison invented a lamp with a carbonized thread for a filament, sealed in an airtight glass tube. Within a few years the cystoscope, the œsophagoscope, the proctoscope and the bronchoscope had come into use. The perfection of these and similar instruments since 1895, again offers an increased field of exact observation. Accuracy in diagnosis has contributed largely to the confidence of the medical practitioner and the general public in surgical work, and modern surgery is built on this confidence.

One may say that surgical technic has now advanced to the point where any structure in the body can be exposed, inspected and manipulated. With the perfection of skill there has been a perfection of instruments, appliances and media. The science of chemistry will undoubtedly furnish better local anæsthetics and antiseptics. It seems highly probable that among the endless synthetic compounds one will be found less poisonous and more powerful than any that we now possess. The trend as recorded seems to indicate lessened risk from infection and lessened risk from induced anæsthesia and, with the latter, a distinct increase in the use of local and regional anæsthesia. As the limit of absolute safety is approached a slower and slower advance is to be expected.

The field of surgery presents a different and a most interesting problem. It has changed and will certainly change. The disorders turned over to the surgeon from the earliest times have been injuries, congenital malformations, acquired deformities, foreign bodies and concretions, certain phases of the

defense reaction of the body to infection, and the removal of tumors. There has been added in recent years an effort to control and regulate function by mechanical means.

One may say with reasonable assurance that congenital malformations, hernias, cleft palates, pilonidal cysts and branchiogenic cysts and sinuses, congenital pyloric stenoses, Meckel's diverticulum, patent urachus, exstrophy of the bladder, etc., will come to the surgeon as they have in the past for rectification and repair. Each year, for reasons we have already referred to, more of these deformities will be turned over to the surgeon.

It is interesting to speculate on the number of injuries in the modern world, in the world of the past and the world of the future. Were more men kicked by horses, thrown or run away with than are smashed by motor cars, hurt in railway accidents and disabled by modern machinery? Will the wider use of the airplane, with diminished hazard of collision and added hazard of falling, increase or decrease the number injured? One can only make passing observations. In a country with prohibition in the constitution, in one small park in a large city, two lamp posts a week are destroyed by motor cars in head-on collisions. I believe injuries in proportion to the population are increasing, not decreasing; that the curious tendency to crowd closer and closer together in urban centres and to use more powerful and swifter moving machines is accompanied by largely increased risk of injuries. The surgeon of the future will have more, not fewer injuries to treat.

Is warfare to be more or less destructive? The perfection of guns, projectiles and explosive substances seems to suggest but one answer. In Captain B. H. Liddell Hart's little book on "The Future of War", he points out that, by a curious combination of sentimental pacifists and traditional militarists, the most merciful weapon yet devised has been outlawed, namely, poison gas. "Even with the lethal gases of the last war, the use of which was decried as barbarous by conventional sentimentalists, statistics show that the proportion of deaths to the number temporarily incapacitated was far less than with the accepted weapons, such as bullets and shells." He quotes the views of a high German authority, General von Altrock: "In wars of the future the initial hostile attacks will be . . . against its large cities, factory centres, munition areas, water, gas and light supplies. Discharge of poison gases will become the rule. Entire regions inhabited by peaceful populations will be continually threatened with extinction." Captain Hart's conclusion is that the weapon, the target and the aim will alike be civil. The work of the surgeon in war may be largely in the civil hospitals.

Foreign bodies and concretions in the ducts of glands fall to the surgeon. Is the time coming when a knowledge of the chemistry of secretions will be sufficient to prevent the formation of calculi, or will a synthetic drug be discovered with solvent action on the constituents of stones? It is possible, but the factors entering into their formation are so complex, the part played by infection and even possibly by the congenital peculiarities which tend to produce stasis is so imperfectly understood that it is conjectural if, for years,

there will be a better means at our disposal than to remove them when they have once formed.

The surgeon, from the earliest times, has opened abscesses and removed infected foreign bodies and necrotic tissue. He learned empirically, at least two thousand years ago, the efficacy of these measures. The better understanding of the nature of infection led for a time to the radical removal of all centres of infection. There was a period when primary chancres were cut out, anthrax pustules widely removed, secondarily infected glands excised and incisions made in erysipelas. If pyogenic infection progressed it was assumed that the cuts were not long enough or deep enough. The trend of opinion in recent years, guided by more exact knowledge of the sequence of events that follow one another when microörganisms are introduced into the body, has modified these practices. It is generally recognized that anthrax does better with the introduction of serum, without excision, than with excision. We now know that during the period of first incubation, between the contaminating contact and the appearance of the primary lesion, the spirochætæ have passed into the lymphatics. The future will elucidate still further all these questions. There may be less, rather than more, surgery in this particular field. With more exact understanding of the way accidental inoculation takes place, the various infections should decrease. Tuberculosis is apparently decreasing. Should it be eliminated or brought under control, as it may well be, a large field of surgical practice would be removed. Syphilis, in some countries at least, is on the increase, but the severer forms leading to ulcerative and disfiguring deformities that came so often into the hands of the surgeons of the past seem to be decreasing, due to early recognition and prompter treatment and probably also to more resistance on the part of the subject or an attenuated virus. The philosopher, Doctor Panglos, in 1798, lost an eye and most of his nose before he was cured. I recommend the perusal of the genealogy of his infection in Voltaire's "Candide".

The introduction of chemotherapy by Ehrlich, with a direct attack on the causative agent, brings up the interesting question of the possibility of a sterilisans magna which, injected directly into the blood, will destroy microparasites. Among the endless synthetic compounds will one be found that interferes with the life and nutrition of the minute vegetable cells and yet does not interfere with the life, nutrition and function of the far more delicate animal cells? It is evident that, one by one, the animal parasites are being brought under control by chemical substances. The toxic effect of antimony on the ova of bilharzia is a recent and conspicuous example. There is little evidence as yet of such control in the group of bacteria.

The doctrine of focal infections advanced in the last ten years has had a tendency to increase the number of operations. There has grown up a widespread belief in the efficacy of the removal of the teeth, tonsils, gall-bladders. appendices, etc., in many instances showing such slightly morbid changes that they are within the range of similar structures which it has been proved over

and over again most of us are carrying about without conscious detriment to our well being. I believe this tendency will increase. The impulse comes from the reports of striking improvement in a variety of chronic ailments, such as arthritis, neuralgia, headache, lassitude, world weariness, etc., which I assume may even become more frequent in the future.

Surgeons have excised tumors for years. With more exact notions of the course of malignant neoplasms and a more careful study of the characteristics of the different types, it has become evident that in a considerable number of cases the results have been disappointing. The systematic effort to follow patients that have been operated on, year after year, has brought knowledge of late recurrences. The curious observation that even the wide removal of small neoplasms has not always resulted in curing the patient, and the converse, that patients have remained well for years after the excision of extensive neoplasms fairly close to the growth, have both been disconcerting.

There has grown up at the same time a knowledge of the destructive and inhibiting effect of X-rays either emitted by the X-ray tube or by radium. Growths in certain regions have passed out of the domain of operative surgery. In carcinoma of the cervix, for example, radium has come to be the method of choice. It is recognized today that both surgery and the X-ray have a place; that the best we can do for cancer is still to excise it widely; but that frequently an operation must be considered palliative and supplemented by other methods. These changes in the attitude of the surgeon toward neoplasms have all been admirably reviewed in a recent paper by Prof. F. C. Wood.

The knowledge that cancer develops most frequently in areas of chronic ulceration and in slightly damaged tissue has introduced the conception of a pre-cancerous stage. A widespread belief has grown up that all areas that have been subject to chronic irritation, all chronic ulcerations, moles, warts, senile keratoses, healed lacerations, etc., should be removed. This is increasing the field of surgery at present and probably will do so even more in the immediate future.

What will the future show? A few days ago I told one of my friends who has specialized in the subject of malignancy and whose acumen, experience and sceptical attitude are widely known, that I was going to suggest as a possibility that within a hundred years the etiology of malignant neoplasms would be known. He replied: "It is possible within a thousand years." I made bold to suggest, however, that within fifty years we may know enough to completely change surgical practice and to remove certain at least of the new growths altogether from the field of surgery and that we shall look back on our present efforts as extraordinarily crude. I admit today that the student of malignancy is bound to feel as Harvey felt when he first watched the beating of the tumultuous heart and attempted to make out the sequence of happenings. He wrote, you remember: "When I first gave my mind to vivisections, as a means of discovering the motions and uses of

the heart, and sought to discover these from actual inspection and not from the writings of others, I found the task so truly arduous, so full of difficulties, that I was tempted to think, with Fracastorius, that the motion of the heart was only to be comprehended by God." But the circulation was discovered and the movements of the heart made clear, notwithstanding Fracastorius, and all seems simple today.

One may say that thirty years ago a surgeon was concerned with the anatomical consideration of whether he could remove a given tumor. Today, having mastered the technical difficulties, he is confronted with the question as to how much he accomplishes with a given mutilation and as to when a given area of chronic irritation is to be considered a precursor of cancer.

The control of abnormal function, when accompanied by obvious hypertrophy of a gland, has furnished conspicuous successes in the surgery of the spleen and partial successes in the surgery of the thyroid. The extirpation, excision and division of nerves has, for years, been a recognized measure in treating intolerable neuralgias. Recently there has been tendency, guided by these experiences, to extend the field. The suprarenal of normal size and appearance, for example, has been partially excised for epilepsy, neurasthenia and in conjunction with the thyroid for exophthalmic goitre. It has been partially removed in a number of instances for gangrene due to endarteritis and Raynaud's disease.

Twenty-two years ago Jonnesco reported a series of 159 cases in which he had removed the cervical sympathetic ganglia and chain. Twenty-five of these were in exophthalmic goitre and were reported as complete successes, every symptom disappearing. Recently a number of operations have been introduced on other portions of the involuntary nervous system to control spasm or supposed spasm or to cause dilatation. Portions of the autonomic system that supply the pylorus have been excised to relieve pyloric spasm; the perivascular sympathetic fibres have been removed to cure various conditions such as chronic ulceration, gangrene, causalgia, Raynaud's disease, etc. Peripheral facial paralysis has been treated by removing the superior cervical sympathetic ganglion. The lumbar sympathetic ganglia have been removed to relieve congenital megacolon. It is unnecessary to multiply examples. New operations are appearing and will continue to appear in this field.

Surgery seems to be changing from a science largely concerned with normal anatomy and palpable and visible morbid anatomy to one especially concerned with normal and morbid physiology. Disturbances of function were, in the past, only considered when obviously connected with gross alteration in structure. The surgery of yesterday was dominated by anatomy, the surgery of today is dominated by physiology and the surgery of tomorrow will be more so.

Which of these newer procedures will survive and take a permanent place in surgery? One can only say that few, so far, have gained any widespread recognition. They have been introduced for the most part as being successful

in practice, the reason of the efficacy of the procedure being unknown. The proof of their virtue is founded on the reports of a few cases in which improvement occurred and which, in the early reports, is nearly always described as "truly astonishing". The value of many of these procedures may be in the stimulus given to exact study to affirm or refute the theory propounded and the results reported. Unfortunately medical history is filled with similar reports of extraordinary cures resulting from all sorts of drugs and chemicals and all manner of procedures. I recommend anyone who is interested in the subject to look up the different measures which have cured or benefited either epilepsy or erysipelas.

The surgeon of the past read and studied anatomy and then worked out his operation on the cadaver. I believe the surgeon of the future will read and study physiology as he studied anatomy in the past and as he worked out the technic of his operation from the anatomical standpoint, so in the future, he will think of the purpose of his operation after careful consideration of the experimental facts already given in the text-books of physiology.

Will the future show not only an effort to control function by excision but by transplantation? Will a technic be perfected which will make transplantation as frequent as partial excision? Will failing function in an organ like the kidney be restored by transplanting a sound kidney? I remember a discussion just after Carrel and Guthrie, twenty-two years ago, reported "The successful transplantation of both kidneys from a dog into a bitch with the removal of both normal kidneys from the latter," in which such a prediction was made. It seemed to me at the time unlikely. Are Voronoff and Steinach correct and will the surgery of the future record thousands of operations transplanting monkey glands and cutting off the vas deferens? As exact knowledge accumulates it seems to me that the trend will be toward diminishing rather than increasing surgical practice in all these fields. With an exact knowledge of the so-called endocrine balance, with the introduction of artificial chemical imitations of the various hormones, with the possibility of exact knowledge of the cause of the insufficiency or overactivity, may we not look back even on the effort to control an over-acting thyroid by cutting portions of it away, without the slightest knowledge of the agents that have incited it to increased activity, as but an improvised measure?

It seems to me less fanciful to imagine a knowledge sufficient to enable a recognition of the causes of chronic changes in the kidneys, and their avoidance, than to imagine the social rearrangements necessary to obtain sound human kidneys and the difficulties in technic necessary to keep a highly specialized organ like the kidney alive outside the body for any length of time. Notwithstanding the vigor and lust of the goat described by Voronoff, after testicular grafting, my imagination finds it simpler to see a possible return to a perfection of the method of Brown-Séquard. Old men may take, each morning, a potent chemical product, the exact imitation of a testicular hormone, and have the delusions of youth return. Old men, that is, who have

not the wisdom of Cephalus, that delightful old man recorded in Plato's "Republic" who, when asked what report he gave of old age, quoted a saying of the aged Sophocles who, in reply to a similar question said: "Peace, I feel as if I had escaped from a mad and furious master."

One of the most brilliant and best known surgeons of France, Leriche, in his address on taking the Chair of Surgery in Strassburg, delivered in 1925, spoke on the future of surgery. I wish to call your attention to the views expressed. "Surgery" he said, "has become one of the most important branches of physiology and if its supreme aim is therapeutic it has equally as an aim the knowledge of the healthy man and the sick man, and should be considered as one of the normal procedures in the study of biology. Surgery has arrived at the end of a period largely clinical and technical. It has taken forty years to arrive at this mastery. During this short period it has accomplished a considerable work; it has acquired an admirable sureness in its acts; it has created its methods, studied the morbid physiology of some disorders, fixed the nature, the pathological anatomy and the evolution of a great number of diseases; it has prepared the balance sheet of its possibilities and called in its long term notes. Now, proud but not satisfied, it is at its apogee."

Leriche depicts the future. He sets before the mind's eye his conception of an operation on the heart, accomplished not by dividing a stenosed valve, which may readily heal again, as has been done, but "under certain conditions of cardiac arythmia rebellious to medication, the cutting of some small branch at the base of the neck, the suppression of which will diminish the excitability of the musculature of the auricle." He goes on to say that to many minds, to all appearances excellent but in reality commonplace, there is a divorce between the practice of surgery and these scientific aims.

I beg to place myself among these ordinary minds. I think a surgeon should read, mark and inwardly digest all that he can of physiology, pathology and bacteriology; that he should observe accurately and record with a scrupulous exactness, all that comes in his way in his unrivaled opportunity to see and study normal and abnormal function and structure; that he should be scientifically minded and scientifically educated and should heartily dislike unchecked reports and unverified theories. He should recognize that proof lies not in a few observations made shortly after a given procedure. He should be aware of the multitude of interfering conditions and remember that the experimental method is part of scientific verification. But he should know that his aim is solely curative and that all the rest is incidental. He gains his livelihood by his procedures and is under scrupulous obligation in this regard. Otherwise he should narrow his fields of observation and become an experimental physiologist, and he should have a scientific recognition of the difference between an experimental physiologist and a surgeon. I will give an example. I read in a physiology recently published, in an article on "Coagulation" the following statement: "Surgeons have frequently noticed

that total hysterectomy is less grave than subtotal. In the latter case, at times, one sees death from embolism. It seems as if the surface of the divided uterine muscle exerted an action favorable for thrombosis." How many observations led to this conclusion? How careful were the observations made on the source of the primary thrombus? Is this a scientific statement and was the surgeon, as a physiologist, contributing a verified fact?

All has a bearing on the future of surgery. Is surgery about to enter on an experimental phase; is it about to abandon the sure footing which has kept it free from much of the jargon of the medical practitioner? It seems to me unlikely. It seems far more probable that the future will show surgery guided largely by common sense as it has been in the past, with an instinctive distrust of all that cannot be demonstrated by a large body of results. The practical mind of the surgeon will again perhaps be rather too incredulous rather than too credulous of new procedures and ideas.

All great advances so far have come from the allied sciences. We owe even the anæsthetics nitrous oxide, ether and chloroform to the English chemist Davy, to another English chemist and physicist Faraday and the French scientist, Flourens, although we associate their practical introduction with the names of two American dentists and a Scottish physician. A professor of chemistry, Pasteur, made the great induction that microparasites caused infection. Röntgen, a pure physicist, introduced the X-ray. Has science nothing more to offer? I feel certain it has.

We may, to be sure, be starting on a phase when advance, for a long time, will be hardly perceptible, as in the period between Galen and Vesalius. We may have reached the limit of modern technical methods. The microscope and the methods of staining tissues may reveal nothing further. Physiology and physics may become more and more esoteric, given over to formulæ and curves intelligible only to the initiated. I do not believe it. If you look at the past there has been this extraordinary elucidation of one thing after another going on, teaching nothing of the ultimate meaning of things, increasing, not diminishing the mystery, but leading us by definite and logical action to avoid and produce certain sequences. Knowledge is cumulative and the successive additions seem to be coming faster and faster.

That the surgeon of the future will have far more exact knowledge of things pertaining to his art to aid him, I cannot question. That medical science may take much out of the field of surgery that we think of today as permanently there, seems to me likely and that it may bring certain disorders incidental to new conditions into its sphere seems probable.

But the new knowledge will but increase the difficulty of understanding the ultimate causes of things. As Maeterlinck says somewhere, I think in the "Life of the Bee": "The purpose of knowledge is to increase our fields of conscious ignorance." Matter was comfortably defined when I was in college as anything that occupies space or as that which we can perceive by our sense of touch. Today the material world is uneasily poised on immaterial atoms.

I give a recent definition of matter: "Matter is but the sequence of events in experience and nature." We may even be about to find out and bridge over the bond between the physico-chemical on the one hand and the vital on the other. Therefore the comfort of working in one of the great handicrafts of today and tomorrow, one which deals with proximate and obvious causes, and aims at performing its manual acts so deftly and so gently that pain is relieved, deformities corrected, the normal workings of the body restored with trifling damage to the delicate living cells, and little disturbance to the organism as a whole.

Doctor Panglos, the great optimistic philosopher, said to Candide: "There is a concatenation of events in this best of all possible worlds." "All that is very well," answered Candide, "but let us cultivate our garden."

# THE BIOLOGICAL EFFECTS OF THE X-RAY AND RADIUM AS AN AID IN THE DIAGNOSIS OF NEOPLASTIC DISEASES

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The study of the biological effects of the X-ray and radium has been related largely to their therapeutic value in neoplastic diseases, and a very considerable literature has been accumulated in regard to their clinical manifestations. Their mode of action also has been a subject of extensive discussion without yielding from the physicochemical standpoint any decisive conclusions. Within the domain of pathology, however, much valuable knowledge has been obtained from the observation of the morphological changes of the normal and tumor tissues which these agents produce. Added interest has been given recently to these changes by the efforts that are being made to grade the malignant qualities of tumors from their histological structure. So far it has been found possible by this method to foretell the radiation reaction with only a moderate degree of certainty. We have found, however, that the radiation reaction does indicate the histological type of tumor, and it is the purpose of this paper to show that the recognition of the radiation reactions, if combined with a careful review of the clinical setting, may afford much aid in the differential diagnosis of tumors.

As a result of the radiation treatment of tumors, the terms radio-sensitive and radio-resistant are becoming widely used as expressing the radiation reaction without giving them an accurate meaning, thereby causing confusion in regard to their applicability. It is generally recognized that certain tumors are very sensitive to the application of these agents without much relation to the dosage. For the present purpose, therefore, we would limit the term radio-sensitive to those tumors which show a prompt, rapid and easily appreciable regression after one application of either the X-ray or radium in a dosage insufficient to cause nutritional changes in the neighboring tissues. There may be differences in the degree of their response, but all tumors of this class show a specific reaction in that it is appreciably different from that of all other tumors to which we would apply the term radio-resistant. Among these, also, there are wide differences in their radiation reaction, but in none of them can the reaction be confused with that occurring in the class we have proposed to call radio-sensitive.

It is now known that tumors of the radio-sensitive type have a common histological structure without regard to their histogenesis. They may be sarcoma or carcinoma, but they are always very cellular with little or no supporting stroma. The cells are of the embryonal or anaplastic type; these tumors are very malignant, metastasize easily and are practically inoperable.

Moreover, this reaction may be regarded as specific in that all tumors of this type without regard to their size or location respond in the same way. A considerable number of tumors of this type are already recognized, so that by observing the comparative amount and rapidity of their regression an otherwise obscure tumor may be identified.

The observation of this reaction in metastases is especially valuable in differential diagnosis, for the general law of the preservation of the structural type is confirmed by the similarity of the reaction to that of the primary tumor. In accordance, therefore, with the tendency of metastases to show an increase of anaplasia, the radiation reaction is often more favorable in the metastases. We have occasionally observed, for example, radio-sensitiveness in lung metastases from radio-resistant bone tumors. The metastases, also, from teratoid tumors of the testicle almost uniformly show a more favorable reaction than the primary tumor, which, beginning as an anaplastic tumor and hence offering less room for an anaplastic increase, yet has metastases which become more simple because certain resistant elements of the primary tumor may be eliminated. A tumor of the neck, consisting of hard agglutinated nodes and appearing to be secondary to an epidermoid cancer of the mouth but without any such discoverable lesion, disappeared completely and rapidly after one application of radium. This reaction showed conclusively that it was not a squamous cancer, but was one belonging to the radio-sensitive type. A subsequent examination disclosed the absence of the left testicle, which had been removed three years previously but which the patient did not regard as sufficiently important to mention in his history. The diagnosis, therefore, was made of a metastasis from a taratoid tumor of the testicle, which was confirmed subsequently by a report from the surgeon who had removed the testicle. Our knowledge of the favorable radiation reaction of abdominal metastasis from this tumor shows convincingly how a therapeutic test with one or the other of these agents makes unnecessary an exploratory operation. The argument that occasionally no such response by testicular tumors occurs only indicates that all tumors of the testicle do not conform to the undifferentiated anaplastic type. Recently, the clinical features of a metastasis from a testicular tumor in a young boy, indicating that it was not of the teratoid type and that it would not respond to radiation in the way that teratoid tumors do, were confirmed by the slowness of the regression after radiation, and later by the microscopic section of the primary tumor, which showed it to be a spindle-cell sarcoma resembling somewhat a myosarcoma.

The desirability of using a therapeutic test in many situations is emphasized by the spectacular regressions that follow radiation of the Wilms' tumor of the kidney, which is so often the type existing in those bulky abdominal tumors in infants and young children. The frequency with which mediastinal tumors belong to the radio-sensitive type not only emphasizes the therapeutic value of radiation, but shows its value in either confirming a tentative clinical diagnosis or in rendering a diagnosis possible.

That the list of identified radio-sensitive tumors is not yet complete is

attested by the occasional results following the radiation of tumors in organs and tissues which are generally regarded as radio-resistant. The features of the bone tumor designated by Ewing as endothelial myeloma first attracted attention by the complete regression within three weeks after one external application of radium to a tumor of the radius, which had been regarded previously as an osteogenic sarcoma of the radio-resistant type. The death of the patient one year later permitted a study of the tumor, in which its peculiar cellular structure was disclosed and thus accounted for its regression after radium therapy. Other cases of bone tumor appeared with similar X-ray findings and histological structure, and all showing the same radio-sensitive quality, so that finally a characteristic clinical setting was revealed. No other bone tumor has shown the same radio-sensitive quality, except possibly the plasma-cell myeloma, which occasionally approaches it in its response.

More recently the radio-sensitiveness of the so-called transitional-cell carcinoma offers to the clinician an additional resource in the diagnosis of tumors, and to the radiologist a favorable field for radiation therapy. In the case of this tumor, also, the discovery of its uniform radio-sensitive qualities preceded the finding of a common histological structure. Cutler, at the Memorial Hospital, reviewing the records of cases of squamous cancer of the tongue and tonsil, found a group which showed radio-sensitive qualities, and which, after their microscopic sections had been reviewed, were found to have a common histological structure. Ewing had observed the atypical features of their structure, and in this review found that, although resembling the structure of an epidermoid cancer, the cells differed, being round, small, with a large hyperchromatic nucleus and little cytoplasm and without spine formation or hornification. After collating all of the clinical and pathological features, the entity of the tumor was established and its uniform radio-sensitiveness recognized. Our cases have most often been found at the base of the tongue or tonsil, beginning deeply and resulting in comparatively little and superficial ulceration, and making them often difficult to discover even after the formation of metastases, which appear early either in the regional nodes of the neck or in distant organs. According to our records, Cutler found transitional-cell carcinoma in 10 per cent. of the lesions at the base of the tongue and tonsil. They are practically inoperable because of their location and malignant qualities, but it is reasonable to expect that, if identified sufficiently early, a permanent cure by radiation may result. Our records show such tumors also to be located in the larynx, œsophagus, uterus and other organs. These tumors have opened up a wide field for discussion in regard to their histogenesis and exact nature. In Paris, under the term lymph-epithelioma, Regaud is presenting a tumor, the relation of which to the transitional-cell type is uncertain. To us their radio-sensitiveness makes them of special interest, explaining undoubtedly the occasional unexpected results of radiating tumors in regions in which usually no

such events occur. They, also in conjunction with the other tumors of the radio-sensitive type, may offer aid in the field of diagnosis.

A warning, however, must be made against the too wide application of the therapeutic test to tumors in all of the organs of the body. In the breast, for example, it is exceptional for a tumor to show radio-sensitive qualities, and it may therefore be unfair to the patient to delay operation in early and generally recognized operable cases. The tumor of the breast, designated as the inflammatory carcinoma, is usually highly radio-sensitive, is very malignant and a type in which operation has proved to be a failure. Such cases, however, have features by which they can be recognized clinically, thus rendering a therapeutic test unnecessary.

There are numerous factors which alter the normal radiation reaction of radio-sensitive tumors, which, if not recognized, may create a false impression of the value of the therapeutic test. A tumor in which its cellular structure is normally radio-sensitive, as those of the parotid or testicle, may not regress promptly because of the presence of certain radio-resistant elements like cartilage or bone. Infected tumor tissue, cicatricial tissue and fibrosis, either from operation, previous radiation or other sources, always interfere with the normal reaction—a result which we often see in the rodent ulcers of the face because of a previous inadequate treatment. The softening and breaking down of tumor tissues from a nutritional disturbance, occasionally when the patient is in a good general condition, interferes with a normal reaction, and radiation only hastens the necrosis and prevents the normal reparative process. Anæmia with or without cachexia, also, may so alter the normal radio-sensitive qualities of a tumor that a therapeutic test is of no value. It is, in fact, upon the observation of these altered reactions that Ewing has partly based his conclusions relative to the importance of the reparative process in the radiation cure of cancer.

Recognizing, therefore, the factors that may alter the normal reaction of radio-sensitive tumors, our experience shows that the use of the X-ray and radium as a therapeutic test has a special value in the differential diagnosis of the tumors of the lymph-nodes of the neck, often enabling us, if observed in conjunction with the clinical setting, to distinguish between nodes expressing an infective process like tuberculosis and neoplastic nodes secondary to a primary cancer of the mouth, and those expressing the existence of one of those diseases which have been designated as lympho-blastoma, under which we have included lympho-sarcoma, Hodgkin's disease and lymphatic leukæmia. Our experience now extends over a period of ten years, during which we have observed about 1,000 cases of the last three diseases. A large number of these cases have been referred to us with the diagnosis already made from the microscopic section of nodes that have been excised for the purpose of diagnosis. During the early years of our work such was our custom of confirming the clinical diagnosis, but we now rarely excise a node for this purpose because—

(1) The information from the pathologist is often not positive.

(2) Infection frequently follows and the normal regression of the tumors is disturbed.

(3) As our experience has increased we find the reaction of these tumors to the X-ray and radium is so specific that the subsequent course of these cases has usually confirmed the diagnosis we have made in this way.

The differential diagnosis of these diseases is often difficult clinically and may be impossible. Their inter-relationship must also be admitted to exist. We observed, for example, a lympho-sarcoma for seven years, the diagnosis of which had been made by a microscopic section, and which finally terminated under the typical clinical picture of lymphatic leukæmia. It is in the clinically doubtful cases that the pathological report is also doubtful. In other words, a case that is clinically typical of Hodgkin's disease will be so reported by the pathologist, and a case clinically atypical will be reported by the pathologist, also, almost invariably as atypical. A patient referred from another clinic with the diagnosis made from an excised node as Hodgkin's disease (lympho-sarcoma type) illustrates again the difficulty of the pathologist. But in this case the rapid and complete regression which followed the X-ray treatment gave the only positive information regarding the nature of the disease, which undoubtedly was a lympho-sarcoma. The diagnosis of the pathologist depends upon his interpretation of the section, but the regression of the tumor requires no such difficult histological interpretation.

It is not our purpose to show that a microscopic diagnosis is always unnecessary or harmful, for there are numerous clinical settings in which an early and exact diagnosis by the pathologist is necessary for the proper treatment of the case. In the nodes of the neck, however, it is difficult to exaggerate the frequency with which infection and increase of growth activity result from biopsies. In the case of lympho-sarcoma, it is nearly a constant sequel. A boy, the son of a physician, applied to the hospital for radium treatment of a bulky tumor of the neck, in the centre of which a biopsy had been done and from which a diagnosis of lympho-sarcoma had been made two weeks previously. The tumor had grown much faster since the biopsy, and at its site there presented a fungoid bleeding mass, from which already two serious hæmorrhages had occurred. After the application of radium the periphery of the tumor immediately regressed so that within ten days little of the tumor could be felt except the central fungoid mass, from which a subsequent hæmorrhage, in conjunction with a general toxemia, caused his death. Such events are not rare, nor is it a fanciful interpretation of the sequence of events, for many have observed stimulation of the tumor cells by bacterial infection and interference with the tissue repair that is normally induced by radiation. It does not materially lessen the force of the argument to note that in a typical Hodgkin's case a node may be excised with little, if any, harm.

Our experience has enabled us to distinguish between the radiation reactions of lympho-sarcoma, Hodgkin's disease and lymphatic leukæmia. A typical lympho-sarcoma regresses completely within a few days or weeks,

Hodgkin's nodes within a few weeks or months and not always completely, while the nodes of lymphatic leukæmia usually show more resistance and rarely, if ever, is the regression complete. The Hodgkin's nodes show the greatest variations in their radiation reaction, which is undoubtedly due to the variations of structure. Hodgkin in his original description of the disease directed attention to this fact and that they are usually more cellular at the beginning of the disease. The specific quality of the radiation reaction is illustrated by a few cases which resemble true lymphatic leukæmia in the general distribution of discrete nodes throughout the superficial lymphatic system but without the localization of bulky nodes as observed in Hodgkin's disease, and without the blood picture of lymphatic leukæmia. Their reaction to radiation was less favorable than those of Hodgkin's disease, showing practically the same reaction as those of true lymphatic leukæmia. A microscopic section of these nodes invariably gives the picture of pseudo-leukæmia—the radiation reaction, therefore, adding evidence to the generally accepted idea that pseudo-leukæmia is distinct from Hodgkin's disease.

Finally, we wish to direct attention to the applicability of the therapeutic test to those nodular tumors of the neck which are associated with lesions of the tonsils. These cases first apply to us usually after the tonsils have been removed and the nodes of the neck have increased in size since their removal. Or less often, they appear after both the tonsils and the nodes have been removed and a recurrence of nodes in the neck has appeared. A microscopic diagnosis on the tonsils is rarely made so that the incidence of lympho-sarcoma of these organs is unknown, but it has appeared to us that it may be more common than is generally believed. In this tumor a biopsy or a tonsillectomy is a definite menace, because, no matter how definitely localized the tumor appears to be, the surrounding lymphatic structures are always involved, so that even without infection the operation will act as a stimulus to growth activity. A dosage of X-ray or radium sufficient to make a therapeutic test will produce no changes that will make a subsequent operation more difficult or less successful. Among our cases were two otherwise apparently healthy young patients with enlargement of the tonsil and nodular tumors of the neck, which clinically appeared to be typical of lympho-sarcoma, but which might perhaps be regarded by those less familiar with that disease as simple hyperplasia from an infection. One application of the X-ray resulted in a rapid and complete regression. Both of these cases, with the exception of a slight discomfort from dryness of the throat, have remained well for two years. We have no microscopic proof of the exact nature of these tumors, but we know that neither hyperplasia of the tonsils nor of the lymph-nodes responds to radiation in any such way. In hyperplastic nodes from infection there is always an inflammatory reaction without a subsequent regression, which is not observed with malignant neoplasms. If, for example, a tuberculous-node has reached the stage of pus formation without appearing as such clinically, radiation will promptly make the abscess formation plainly apparent. The rapid regression in these cases also shows that

the nodes were not a squamous cancer. They might be regarded as belonging to the transitional type of cancer. Our experience with the radiation reaction to this type of tumor is too recent to permit us as yet to form an accurate judgment of its radiation reaction. At the present time it does not appear to be so constant as that of lympho-sarcoma. The subsequent course of our cases, also, rather confirms the diagnosis of lympho-sarcoma. The features, also, of the primary lesions of the tonsils, marked and uniform enlargement without ulceration, seems to differentiate them from the transitional-cell type, in which ulceration, although it may be slight, usually exists and can be differentiated from lympho-sarcoma. Moreover, our experience with other similar lesions, in which the diagnosis has been confirmed by a microscopic section and in which the primary regression has been the same, leads us to believe that our diagnosis is correct in these cases.

In conclusion our experience indicates that the regression of tumors under radiation is not an accidental or chance phenomenon, but depends upon the structure and nature of the tumors.

With certain tumors the reaction to radiation is so marked, so constant, and so specific, as to make this reaction a valuable aid in diagnosis, so that diagnosis by microscopic section becomes unnecessary. At times, when the microscopic structure is difficult to interpret, the results of radiation may support or alter the histological diagnosis.

# VALUE OF METHYLENE BLUE-GENTIAN VIOLET 5 PER CENT. IN PREOPERATIVE SKIN PREPARATION

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Preliminary to a study of the rationale of the treatment of intraperitoneal inflammatory disease, we took cultures from the peritoneal cavity of apparently clean cases. So many of these cultures were positive that we felt there must be some point of contamination between the skin surface and the peritoneum.

We had always considered that scrubbing the skin with ether and then painting it with 2 per cent. iodine in alcohol was sufficient to produce immediate sterility, but cultures taken from the skin so prepared yielded positive results. We changed our preparation material to 2 per cent. iodine in carbontetrachloride, then to 5 per cent. picric acid, then to 5 per cent. mercurochrome, but positive cultures still persisted. Five per cent. neutral acriflavine gave fewer positives but not consistent sterility.

Since one of the most important factors in wound contamination is the patient's skin, we were much surprised to find that out of the mass of literature on skin preparation very few authors had subjected the various substances which they advocated to severe laboratory and clinical tests. Other factors involved in the operation of the usual clean case are now so carefully controlled that they can rarely be blamed for the appearance of pus in a wound, so absolute skin sterility is essential.

We fear that surgeons too often leave the choice of the substance they use for skin preparation to habit, or the glowing claims of drug houses.

The development of the methylene blue-gentian violet 5 mixture is the result of our attempt to produce a positive skin antiseptic to replace those which were only partially effective.

It is probable that no operation is ever performed under absolutely aseptic conditions. Wounds are contaminated because bacteria in such large numbers or of such virulent strains are introduced into them that the tissue resistance is overcome.

The use of aniline dyes as an antiseptic is rapidly becoming popular. Tinker and Churchman have contributed more to the literature of the subject than any other American writers. Churchman's work has in the main been theoretical, or rather from the standpoint of the bacteriologist. But Tinker has for many years advocated their use as a preparation of the skin before operation. The solution which Tinker advocated was 5 per cent. gentian violet and 5 per cent. neutral acriflavine in 50 per cent. alcohol. There are two objections to this solution: first, it is unstable and, second, a

factor which cannot be neglected in this day of hospital economy, it is extremely expensive.

In thinking over Tinker's article, it occurred to us that all of the properties of neutral acriflavine are enjoyed by methylene blue, a substance which has been used as an antiseptic in many ways previously, and it occurred to us to try to substitute it for acriflavine and see what happened. We had seen it used on the skin by Bonny in London.

The substance which resulted from this substitution, which we call MBGV5, is a solution containing 5 per cent. commercial methylene blue crystals, 5 per cent. commercial gentian violet crystals in 50 per cent. commercial grain alcohol. This solution is readily made stable over a period of months and costs about seven cents an ounce to make up in a hospital.

The ideal substance for preoperative skin sterilization must answer the following requirements:

1. It must kill the common skin-contaminating organisms immediately. It must inhibit the growth of, or render non-virulent, any of the uncommon skin-contaminating organisms such as the anaërobes.

2. It must retain its ability to sterilize for at least one to two hours.

3. It must be readily visible in order that its limits may not be mistaken.

4. It must be non-toxic and non-irritating to the skin.

5. It must not interfere with the reparative processes.

6. It must be stable.

7. It must not interfere with the physiology of the skin.

It seemed to us that the best method of testing the efficiency of the skin antiseptic was to subject it to conditions similar to those which it must meet in the course of an operation. The determination of the phenol coefficient of an antiseptic is not sufficient as a recommendation. As surgeons, what we want to know is when an antiseptic is brought in contact with the bacteria on the skin, does it or does it not render that skin aseptic? Can we make an incision through that skin area and not carry into the subcutaneous tissues bacteria which will later on produce a wound infection? The effect of an antiseptic on bacteria in a test tube and under laboratory conditions may not be the same as its effect upon similar bacteria when in their natural habitat.

With this in view, it seemed to us that we must subject MBGV5 to conditions which closely similate those that arise during the course of a surgical procedure. Our first step was to determine what standards of asepsis we would use, and what our technic would be to determine the effect of the antiseptic on skin bacteria. Almost every article advocating the use of a special skin antiseptic offers a special technic. After carefully considering them we decided that they must all be rejected because the technics described depended to too large an extent upon the personal factor. For instance, if after the application of an antiseptic the skin is scraped with a sterile knife and these scrapings culture, it is obvious that the intensity with which the scraping is performed is an extremely variable factor. The same criti-

cism applies to the rubbing of swabs or other instruments upon the skin after the antiseptic has been applied, and dropping it into culture material. This is a procedure which is practicable only on experimental animals, as it adds to the scarring and increases slightly the operative risk.

We decided to adopt the following method of skin culturing because it is applicable to use during the course of any operation, and is practically individual proof.

Cotton was wound onto wooden applicator sticks to make swabs of equal size. By having the same individual make these, the area of the tip of the swabs is remarkably uniform. They were sterilized in batches of 200 in large test tubes. Two controls were taken from each batch. About one inch of beef infusion broth (Ph. 7.2 to 7.6) was placed in four-inch tubes, numbered and sterilized in racks.

When the culture was to be taken from the skin of the patient, the following method was always employed: The sterile swab was moistened in sterile media, the swab was then held in contact with the skin without rubbing or using more pressure than was necessary to hold it in place for thirty seconds by a stop watch. The swab was first thoroughly rinsed off in a tube of media and then discarded. The media tube was flamed every time it was opened. The tubes containing the media were then incubated at 37° Centigrade for five days. Those which showed any cloudiness whatsoever were examined microscopically and the organism identified. (We call attention to the fact that this technic leaves practically no room for variation.)

We selected as our subject children and adults who were recuperating from non-surgical conditions. The abdomen was divided into five sectors by lines drawn with the dye radiating from the umbilicus. Cultures were taken from each of these areas as controls. Of 233, eighty were positive.

Five antiseptics were tested by applying one to each of the sectors of skin, the application was made with a sterile swab, the sectors were rotated, and cultures were taken by the previously described method at ten-minute intervals for one hour.

We cannot fail to take into consideration the fact that during the course of an operation, whether it be under general or local anæsthetic, the skin of the patient is constantly perspiring. This means that bacteria are being brought up from the depths of the sweat glands and the hair follicles and poured onto the skin surface. Some of the antiseptic used should be on the skin surface ready to meet these organisms during the entire course of the operation. If those who use iodine will bear this fact in mind, unless the iodine has been used in seven-and-one-half strength and not rubbed off with alcohol, a procedure which is extremely apt to produce severe skin reactions, they will notice that at the end of the operation, if it is over an hour in duration, the iodine stain has practically disappeared. And if they will take cultures from the skin at this time they will find that growths of staphylococci and streptococci can be obtained.

Some skin antiseptics such as picric acid had been advocated on the

ground that they tanned the skin and that through this tough, leather-like covering bacteria could not gain access to the surgical area. The efficiency of this method cannot be criticised theoretically, but it is at once apparent that if this coating is lacerated, this method of sterilization is immediately rendered useless. Such lacerations, due to the presence of instruments or rubbing the skin, cannot be avoided. In using MBGV5, which is a very noticeable stain, we have frequently observed that an area of about one inch on each side of the incision will be almost white when the operation is finished, which goes to show that the tendency to rub materials off this area is considerable.

We mentioned the fact that our ideal skin antiseptic must maintain its potency for at least one to two hours. Hence all of our tests were conducted for at least an hour and some of them for two and one-half hours, during the course of which the skin was not protected in any manner and was left open to contamination as it would occur in the wards of general hospitals.



Fig. 1.—Graphic chart showing the comparative efficiency of the five antiseptics used in the previous experiment. A, ether; B, 2 per cent. mercurochrome; C, 3 per cent. picric acid; D, 2 per cent. iodine; E, MBGV5.

We have now defined the requirements of our ideal antiseptic and specified the conditions under which the efficiency must be tested.

We proceed to recount our experiments.

The five antiseptics tested were ether, 2 per cent. mercurochrome in aqueous solution, 3 per cent. picric acid, 2 per cent. iodine in alcohol, and MBGV5.

A consideration of the foregoing led us to believe that in MBGV5 we had an antiseptic of extreme efficiency, but we were not satisfied. We determined to subject it to more rigorous conditions by adding fresh cultures of bacteria in order that we might be sure that we were dealing with skin which was actively contaminated. Naturally we felt that we were not justified in doing this on humans until we had first tried it on the skin of laboratory animals. Rabbits were used, the experiment being conducted as follows:

On the day preceding the experiment the abdomens of the rabbits were

clipped and all the hair removed by shaving, care being taken not to lacerate the skin. The animal was tied down on its back on a board and the abdomen marked off into four sections. Twenty-four-hour cultures containing staphylococci and streptococci from a carbuncle B. subtilis from the laboratory strain were rubbed onto these areas and allowed to dry for one minute.

| Material used to disinfect unprepared skin | Time after application of disinfectant cultures taken | Number of times tried | Number of negative growths obtained | Percentage of negative growths obtained |
|---|---|---|---|---|
| Ether ............. | 10 min. | 47 | 31 | 69 |
| Ether ............. | 20 min. | 47 | 24 | 51 |
| Ether ............. | 30 min. | 47 | 30 | 63 |
| Ether ............. | 40 min. | 47 | 20 | 42 |
| Ether ............. | 50 min. | 47 | 23 | 48 |
| Ether ............. | 60 min. | 47 | 26 | 56 |
| | | Total 282 | Total 154 | Average 54.8 |
| Mercurochrome 2%... | 10 min. | 47 | 29 | 62 |
| Mercurochrome 2%... | 20 min. | 47 | 28 | 59 |
| Mercurochrome 2%... | 30 min. | 47 | 29 | 62 |
| Mercurochrome 2%... | 40 min. | 47 | 31 | 66 |
| Mercurochrome 2%... | 50 min. | 47 | 29 | 62 |
| Mercurochrome 2%... | 60 min. | 47 | 26 | 55 |
| | | Total 282 | Total 172 | Average 61.1 |
| Picric acid 3%....... | 10 min. | 47 | 42 | 89 |
| Picric acid 3%....... | 20 min. | 47 | 36 | 77 |
| Picric acid 3%....... | 30 min. | 47 | 42 | 89 |
| Picric acid 3%....... | 40 min. | 47 | 34 | 75 |
| Picric acid 3%....... | 50 min. | 47 | 39 | 83 |
| Picric acid 3%....... | 60 min. | 47 | 29 | 62 |
| | | Total 282 | Total 222 | Average 79.1 |
| Iodine 2%........... | 10 min. | 45 | 40 | 88 |
| Iodine 2%........... | 20 min. | 45 | 37 | 82 |
| Iodine 2%........... | 30 min. | 45 | 37 | 82 |
| Iodine 2%........... | 40 min. | 45 | 40 | 88 |
| Iodine 2%........... | 50 min. | 45 | 38 | 84 |
| Iodine 2%........... | 60 min. | 45 | 32 | 71 |
| | | Total 270 | Total 224 | Average 82.5 |
| Methylene blue 5%... | 10 min. | 47 | 47 | 100 |
| Gentian violet 5%... | 20 min. | 47 | 47 | 100 |
| | 30 min. | 47 | 47 | 100 |
| | 40 min. | 47 | 47 | 100 |
| | 50 min. | 47 | 47 | 100 |
| | 60 min. | 47 | 47 | 100 |
| | | Total 282 | Total 282 | Average 100 |

Control cultures were taken immediately, all of them being positive. Each of the four areas was then painted with an antiseptic as in the previous experiment. The antiseptics used were the same except that we did not test ether alone, we increased the percentage of mercurochrome to 5 per cent. Cultures were taken from each of these areas by the usual method at half-hour intervals for two and one-half hours. These cultures were then incubated for five days and the results recorded. This procedure was carried out on two areas on each of five animals.

In selecting the bacteria to add to the skin we chose staphylococci and streptococci because they are common skin contaminating organisms and added B. subtilis for two reasons: (1) because it is air-borne and (2) because it is a gram negative spore bearer. We increased the duration of the experiment to two and one-half hours because that is the maximum time required for major surgical procedures.

From a consideration of the foregoing results we felt that we were justified in continuing our investigation to the extent of adding the same bacteria to human abdomens. In order that we might not leave a skin which was abnormally contaminated, at the close of each experiment the entire area was painted with MBGV5. All of these control cultures were negative.



FIG. 2.—Graphic chart showing the comparative efficiency of the four antiseptics used in the previous experiment. B, 5 per cent. mercurochrome; C, 3 per cent. picric acid; D, 2 per cent. iodine; MBGV5.

Hill and Scott (*Journal of Urology*, Aug., 1925, p. 135) recommend the use of 2 per cent. mercurochrome in a solvent containing water, alcohol and acetone. The following is a table showing the result of a comparison of this antiseptic with MBGV5. The subjects were human medical convalescents; the bacteria added to the skin were staphylococci, streptococci and B. subtilis. The abdomens were divided into six areas, three of which were painted with mercurochrome, acetone and alcohol, and three with MBGV5.

| | Areas painted | Control | 15 min. | 30 min. | 45 min. | 60 min. | 75 min. |
|---|---|---|---|---|---|---|---|
| Mercurochrome } Acetone } Alcohol } | 48 | 48+ | 27— | 22— | 24— | 25— | 35— |
| MBGV5 ......... | 48 | 48+ | 48 | 48 | 48 | 48 | 48 |

Under the same conditions as the preceding experiment we compared

the efficiency of MBGV5, 5 per cent. neutral acriflavine in acetone alcohol solvent and a proprietary antiseptic (x) dilution of one-five-hundredth.

We tried reducing the percentage of methylene blue and gentian violet from 5 to 4, 3, 2, and 1, and found that 5 per cent. was the least concentration at which the antiseptic was 100 per cent. efficient according to our standards.

In the preceding experiments we have subjected MBGV5 to the most difficult tests which simulate actual clinical conditions and find that in it we have an antiseptic which gives us better results than any with which we have compared it. We are now using it as a routine skin preparation, its application being preceded by a thorough scrubbing of the skin with ether. This we believe is a procedure of the utmost importance, as by it a large portion of the sebaceous material and fat is removed from the skin, giving the dye a chance to penetrate into the recesses of the glands and follicles in the skin.

Cultures taken from under pads which have been on the patients during the course of major operations when the skin was prepared with MBGV5 have been consistently negative. In using it on over three hundred clean abdominal cases over a period of one year we
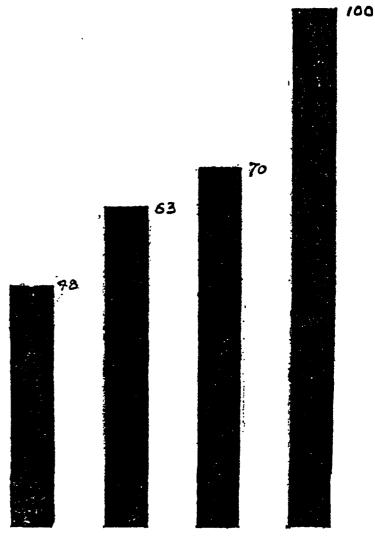


FIG. 3.—Graphic chart showing the comparative efficiency of four antiseptics used in the previous experiment. A, mercurochrome 5 per cent. aqueous solution; B, 5 per cent. neutral acriflavine in acetone alcohol solvent; C, (x) 1–500 aqueous solution; D, MBGV5.

have reduced our incidence of wound infection to less than 1 per cent. In this series we have not included any drained cases, or cases in which infection was present within the peritoneum, although this cavity was not drained. To those interested in using the dye we offer the following suggestions: (1) Since it is such an intense color, as soon as the skin incision is made the skin should be protected with drapes in order that the dye may not be carried down into the tissues on the instruments or surgeon's gloves, thus discoloring the organs

with which it comes in contact, especially when the surgeon depends upon the color of the organ to aid his diagnosis. (2) It can be used without fear of burning or blistering the patient's skin. (3) It is stable for at least a month. (4) It is a true solution and does not require shaking before use. (5) It should be applied to the skin on small sterile swabs held in sponge holders. These swabs or sponges should be discarded into paper bags in order that the stain may not spread to towels and other linen. (6) The dye should not be removed from the skin under the dressings immediately over the wound, but may be removed from the other areas of the abdomen by wiping it off with sponges soaked in "hypozone", after which the skin should be washed with alcohol, as "hypozone" sometimes irritates. (7) The dye can be poured into abscess cavities and when thus used is a highly efficient aid in reducing the amount of infection. (8) If some of the dye gets into the peritoneal cavity the urine during the next twenty-four hours may be bluish. (9) The dye does not interfere with reparative processes.

We feel that MBGV5 meets all of the requirements for an ideal pre-operative skin disinfectant because: (1) We have shown that it does kill the common skin contaminating organisms immediately. (2) We have shown that it will retain its ability for sterilization for at least two and one-half hours. (3) It-is readily visible. (4) Experience has shown that it is non-toxic and non-irritating to the skin. (5) It does not interfere with the reparative processes. (6) It is stable for at least a month. (7) It does not interfere with the physiology of the skin.

To summarize our results. During the past year our records show 277 clean abdominal cases in which MBGV5 following an ether scrub was used as a skin preparation. Of these cases three became infected. One was a Pfannensteil incision in which an operation for bilateral salpingitis, acute, was done. The fat infection which followed may have been due to the pelvic pathology. The second case was a chronic appendix in which a fat infection occurred for which no explanation can be offered. The third case really does not belong in this set of figures at all, because one of the operators in an attempt to lessen the amount of staining, tried to remove the dye with "hypozone" immediately after it was applied.

This work is done under the auspices of the Surgical Research Department of the Department of Surgery, at the Fifth Avenue Hospital.

# THE ALCOHOLIZED NERVE GRAFT

## AN EXPERIMENTAL STUDY

### BY PAUL W. SWEET, M.D.

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BRIDGING nerve gaps is a problem surgery has been attempting to solve for many years. In the light of modern proof as to the manner of growth of the neuro-fibrillæ, many of the methods tried for bridging the gaps have been discarded, and the many methods proposed by numerous more recent investigators is ample proof that the problem is still unsolved. Bringing the two ends of a nerve together inside of formalized arteries, decalcified bone tubes, fresh arteries and veins, celluloid tubes, and fascial tubes have each had their advocates. Neuroplasty, heterogenous and autogenous grafts, bridging the gap with catgut and silk have consistently disappointed. The Medical Research Committee of The British Medical Association investigated many cases of nerve grafting and failed to find one single case of complete recovery, and concluded that end-to-end suture is the method of choice in every case even if resection of bone is necessary for its accomplishment. A brief review of the literature on nerve degeneration and repair may afford a fuller view of the subject.

Peripheral nerve degeneration is a constructive as well as a destructive process. As the neuraxon and its myelin sheath break down and gradually become absorbed, the cells of the fibrous supporting tissue—which constitutes 62 per cent. of the nerve trunk—and also the cells of neuralemmal sheath, begin to rapidly proliferate and rapidly take the place of the part absorbed.

In 1852 Waller advanced the theory that a peripheral nerve, when separated from its trophic centre, the cell, completely degenerates and that regeneration is only from the central stump whose neuraxons are still connected with the central trophic cell. Because of inadequate staining methods he was not able to prove his theory and demonstrate it under the microscope, and it was so hotly contested and his arguments so overwhelmingly battered down that it failed of even a semblance of acceptance. During the years that immediately followed two other theories gained sway and clinical evidence was sufficient to make it impossible to overthrow them, and it was not until Cajal in 1904 brought out his silver stain that the correct theory of Waller again gained recognition and stands to-day as an almost universally recognized fact.

In 1892 Howell and Huber very thoroughly reviewed the literature and found that up to that time three theories had been advanced.

(1) Waller's theory, that that portion of the nerve which has been divided and thus completely separated from its trophic centre completely degenerates, and regeneration is from the undegenerated proximal stump which still remains intact with its trophic cell.

(2) A peripheral axon of a divided peripheral nerve does not degenerate and all that is necessary to regenerate a nerve is to approximate the cut ends which will unite and a new myelin sheath form.

(3) The peripheral axons of a divided nerve degenerate but regeneration takes place throughout the nerve at the same time. In the protoplasmic bands which appear all along the nerve there arise discontinuous fragments of axons which fuse and form the new axons.

In the absence of positive proof of its incorrectness there was so much clinical evidence to substantiate the second theory that for a long time it held recognition; and there is much evidence in the more recent literature to make us stop and question if perhaps in certain instances the peripheral stump does not degenerate. Among the instances on record of a prompt return of function after nerve suture is one reported by Heekes in 1918, where the function of the ulnar began definitely to return six days after suture, the nerve having been shot in two at the internal condyle seven months previously.

In Heekes' article in references, Professor Waller in a letter written in reply to an inquiry concerning such cases says, "in those few cases of prompt recovery which have been recorded no satisfactory explanation has been offered. I am inclined to think that prompt recovery may be due to the stirring up by the operation itself of recurrent sensory fibres belonging to other nerves that may form part of the peripheral distinction and may have had their action in abeyance during complete paralysis before operation." He also adds, "Increased knowledge in the present day of the extensive halo of functional disturbance aroused by an organic focus of real injury would lead me to be on the watch for the possibility of prompt reappearance of sensation by the cerebral suggestion as well as by the peripheral excitation afforded by the operation itself." In taking observations there is a strong personal factor so that some allowance must be made for inaccurate as well as incomplete observation. These apparent exceptions to the rule should bear no weight, however, in our views on the subject of nerve regeneration, for the evidence is too great in favor of the Wallerian theory.

By his histological study von Bungner began the modern investigation in 1891, the year previous to Howell and Huber's work. These were followed by Stroebe (1893-1895), Huber (1895), Ziegler (1896), Galcotti and Levi (1895), Kennedy (1897), and Wieting (1898); all of whose work was from a histological study, yet the real nature of the regenerative process was not shown.

Bethe's publication was of a series of experiments in which the peripheral was separated from the central end first by pulling out the sciatic from the cord and cutting it off far down the thigh and second by cutting three centimetres out of the nerve and bringing the central end up through a muscle. He concluded that these two methods produced the same results. In his conclusions he maintained that there were five stages in the regeneration of nerve fibres. First, that of protoplasmic band formation. Second, differentiation of these bands into axial strands and granular sheaths. Third, appearance of fibrils in the axial strands in the neighborhood of the nuclei. Fourth, fusion of these discontinuously formed fibrils into the fibrillar bands. Fifth, discontinuous formation of a myelin sheath. More recent findings have shown that the first stage only as outlined by Bethe was correct.

In 1893 Stroebe, by the use of his own stain, showed that the neuraxons were outgrowths of the central stump of the intact nerve. He did not, however, show what relationship existed between the protoplasmic bands of von Bungner and the newly-formed neurofibrillæ, but found that the myelin sheath grew from above downward. Two years later Huber (1895), by the use of Stroebe's stain, obtained better pictures than did Stroebe and was the first to demonstrate the small bulbous endings of the most distal portion of the down-growing fibrillæ.

Wilson classifies the degeneration of nerves into three stages. First, there is granulation of the axis cylinders and breaking up of the medullary sheath at the intersegmental lines of Schmidt and Lantermann. The axis cylinders become coarsely granular and the myelin sheath is broken up into fragments. While these processes continue to take place the neurilemma nucleus increases in size and the surrounding protoplasm becomes more abundant. In a normal nerve there is but one nucleus to each neurilemmal internodal segment. In a degenerating nerve mitosis occurs and more than one nucleus lies in a single segment. The second stage is merely a continuation of the processes begun in the first. The myelin and the axis cylinders entirely disappear and the neurilemma nuclei are exceedingly abundant. The third stage is characterized by a marked increase in the protoplasm around the nuclei. This protoplasm increases in amount, forming spindle-shaped homogeneous masses which become confluent and differs from the ordinary cytoplasm in that it is nongranular and stains poorly, thus closely resembling embryonic fibres.

Ingebrigtsen studied the cut ends of a nerve which was incubated in plasma and showed that there grows out from the cut ends of a nerve fibre numerous thin filaments of protoplasm, which are at first tapering and end in a point which shows amæboid movements by means of which they enter the plasma. He also showed that hyperplasia of the neurilemma was only present in those nerves where degeneration had begun. This would seem to prove Nageotti's (1911) contention that the myelin in digesting the axis cylinders furnish the stimulus for the beginning hyperplasia of the neurilemmal sheath nuclei, which theory on the other hand is pretty well upset by Clark's experiments in feeding animals polished rice, thus obtaining the degeneration in the myelin and axis cylinders without change in the neurilemma.

Ranson made a most exhaustive and thorough study and review of the whole field of degenerating and regenerating nerve fibres, and his conclusions are so inclusive and so clearly stated that I give them in full as they probably come the nearest of any in stating the present-day status.

(1) Cajal stain shows that the axons when they first make their appearance in the distal stump are fully developed and clearly differentiated from the surrounding protoplasm. They do not appear as discontinuous fragments arising as new axons in protoplasmic bands through a fusion of longitudinal striations which have developed *in situ*, as was first maintained by Bungner, but are long fibres which when traced peripherally may end within a protoplasmic band with a terminal bulb, and when traced centrally may run out of the section or into a plexus of axons in the scar. Many writers have reached this same conclusion. Perroncito, Marinesco, Poscharissky, Cajal, using the Cajal stain, and Kassin with methylene blue, and Pupura with the Golgi stain.

(2) The attempts to obtain regeneration in the peripheral stump permanently separated from the spinal cord and spinal ganglia have led to negative results. So great is the regenerative energy of the central stump in young animals that the new axons to which it gives rise may bridge very great gaps to reach the distal stump, and new axons may grow in that stump from other nerves.

(3) Axons of both medullated and nonmedullated fibres in the central stump give rise to a large number of branches which make their way through the scar and enter the protoplasmic bands which they use as pathways to the periphery.

(4) The axons of the peripheral stump do not die at once after the division of the nerve, but live for two or three days at least, and undergo changes in the neighborhood

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(4) The axons of the peripheral stump do not die at once after the division of the nerve, but live for two or three days at least, and undergo changes in the neighborhood

of the lesion which must be regarded as an abortive regeneration. After a few days all the newly-formed structures degenerate and disappear. Confirmed by Perroncito, Poscharissky, Marinesco, and Cajal.

(5) Alterations in the axons of the proximal stump can be noticed within twenty-four hours after the lesion. Fine branches are formed and the rearrangement of the neurofibrils of the old axons to form the most complicated networks. These changes occur in the immediate neighborhood of the cut surface and are too varied to summarize in detail.

(6) These phenomena concern the nonmedullated fibres which outnumber the medullated fibres in the spinal nerves.

Kirk and Lewis (1915) have studied the regeneration of nerves, using a fascial tube as a conduit between the two ends of a cut nerve, which they have found fills in from one to twenty-four hours with a jelly-like substance appearing grossly like brain substance but microscopically is of a gelatinous nature with a few white blood cells. Into this substance grow the protoplasmic bands which are at first isolated masses of cytoplasm but which tend to become more protoplasmic as hyperplasia advances. These bands grow downward into the gelatinous mass and form pathways for the neuraxons which grow out of the proximal end of the cut nerve. These begin to branch as high up as two centimetres above the upper end of the section and the nonmedullated ones appear in great numbers, but the branches from the medullated ones predominate, although all medullated first appear as nonmedullated fibres. They state that often there are from 50 to 100 times as many axis cylinders as are present in the nerve several centimetres above the point of section, though they are only about one-tenth the diameter. Each ends in a bud which can be seen at different levels.

Lewis and Kirk confirm Ranson's findings in that the axis cylinders appear first as nonmedullated naked fibres, which spring from either the medullated or nonmedullated cut fibres. They found that the protoplasmic bands grow at the rate of about two millimetres a day, while the axis cylinders grow only one millimetre in three and a half days. A one-centimetre gap was bridged in five weeks. About the sixth week the naked axis cylinders begin to acquire a myelin sheath.

It is well that so many more axis cylinders appear than are normally present, for they do not always follow the protoplasmic bands into the distal end of the nerve, but are lost in the scar or may pass out into the adjoining structure, or may pass down beside the nerve for some distance before passing out into the adjacent structures. Vulpius and Stoffe have shown that if only a comparatively few axons reach the muscle end plates the function of the muscles will be resumed. It must be borne in mind that a muscle capable of function is essential, for no matter how well the neuraxons proliferate function could not be restored if myositis or other degenerative changes have taken place in the muscle.

In their recent article (1917) Kirk and Lewis state that the myelin sheath regenerates from above downward, but whether its origin is from the axis cylinder, the neurilemma, the protoplasmic bands or from none of these is not shown, but they do show that it does not appear in any part until the axis cylinder has been present for at least five weeks and in many of the fibres it appears much later.

Greenman (1916) in studying the regeneration of traumatized nerves found an increase of from 64 to 249 per cent. (maximum increase then would be less than three times normal) in the number of fibrillæ in the regenerated nerve. He showed that on passing from the proximal end of the operated nerve the number of fibrillæ rapidly increase as the region of the lesion is approached, and from the region of the lesion distally the number decreases, but he found that there was a loss of 42 per cent. in the sectional area of the regenerated fibres.

J. E. Sweet (1916) found that enclosing the nerve in a celluloid tube kept the fibres from interlacing, and concluded that the indestructible protecting tube favors rapid and

direct regeneration and has also the added marked advantage of eliminating practically all of the connective tissue interference.

The experiments which I have performed were done with the thought of proving or disproving the contentions of J. Nageotte and L. Sencert in their several papers, namely, that they "shall show how the dead heterogeneous nerve grafts are able to give forth elastic results as good as autogenous living grafts." Nerves from the sciatic, brachial plexus, and vagus of a fœtal calf almost to term (60 to 70 centimetres in length) were removed aseptically and tied to a glass miscroscopic slide so as to keep them straight. These were placed immediately into 80 per cent. alcohol and after twenty-four hours were taken from the glass slides and sealed in test tubes with 50 per cent. alcohol enough to cover them well. No attention was given as to the proximal or distal end of the graft. All technic was aseptic.

Twenty-one dogs of varying ages and sizes were operated on. The thigh of the dog having been properly prepared was opened, care being taken not to produce any more trauma than absolutely necessary. The lines of cleavage were followed in separating the tissues, so that in but very few instances was there any hæmorrhage. The sciatic nerve was elevated out of its bed and by careful sharp dissection it was freed for a distance of four to six centimetres from a point just below the sacrosciatic notch to a point one-half to two-thirds down the thigh, and a clamp placed on that part of the nerve to be removed. Two fine straight needles carrying single strands of very fine Japanese silk were passed through the nerve, one above and one below the forceps and about one and one-half to three centimetres apart. With a sharp cataract knife or safety razor blade the segment held by the forceps was removed, it being cut as near the inserted silk sutures as safety would permit.

The alcoholized nerve, having been soaked in Ringer's solution for half an hour, was held at each end by a pair of forceps, and these same fine needles carrying the fine silk were passed through the graft while being held taut with the forceps, the sutures being placed so that the graft when cut would take the place of the part removed without tension. The graft was then cut off squarely with the sharp instrument. By the time this had been done the slight amount of oozing, which usually occurred from the proximal end of the dog's nerve, had ceased, and if so the graft was put into position and the silk strands loosely tied. Two more sutures were then placed so as to include the nerve sheath only and these sutures were just a trifle more snugly tied. The nerve was now dropped back into place between the muscle sheaths and the wound closed without drainage. Hæmostasis was as nearly perfect as possible before closure was effected. The wound was painted with tincture iodine and no dressing applied.

*Results.*—Specimens were removed at intervals of from seven days to seven months following operation. One dog has not yet been sacrificed. In those dogs which were sacrificed early no electrical stimulation was applied to the nerve at autopsy. A piece of the nerve two to three centimetres above

and three to four centimetres below the graft was removed for microscopical study. The first specimens were split longitudinally and one-half of the nerve stained with silver pyradine (Ranson's modification of the Cajal stain) and the other with hæmotoxylin and eosine. These were embedded in paraffine and cut longitudinally. As the work progressed it was found that in some of the nerves the regenerated fibres were missed, if any had appeared, so the splitting of the nerve was discontinued and only the silver stain was used. In each later autopsy more nerve was removed below the graft and the specimen stretched and tied on a long piece of glass. Blocks were cut from the nerve and sections made both longitudinally and transverse to the nerve fibres. This was a much more satisfactory method and more inclusive.

No dogs died and no wounds became infected except one. which was torn open while the dog was in a fight. Three dogs chewed their legs off up to their knees following the appearance of the trophic ulcers on their feet and these dogs were sacrificed early. Two dogs were allowed to live seven months and both of these had regained the power of dorsal flexion of the foot. One of these, however, had marked trophic disturbance and the foot was twice its normal size. Dog No. 1354 obtained apparently a perfect functional result. The operation was performed on June 21, when three centimetres of the left sciatic was removed and an alcoholized graft from the fœtus of a calf was inserted and held in place by two silk sutures at each end of the graft. The dog developed no trophic ulcers but walked with a decided limp until and sometime after September 20. I did not again see this dog until January 20, at which time she was fat, very frisky and used both hind legs equally well. She was so playful and full of life it was almost impossible to take her picture.

All the dogs with the exceptions noted did exceedingly well, though all walked on the backs of their toes which became sore until the dog learned to protect the affected foot by holding it up and walking on three feet, which some of them early learned to do.

The nerves were examined grossly and microscopically. Upon opening up the tissues the first thing that was noted was that there were, as a rule, very few adhesions to the surrounding structures. This was more striking in some cases than in others, and in checking up the findings hæmorrhage at the time of operation bore a direct relationship to the amount of adhesions formed. In some of the dogs the graft inserted was of greater diameter than the dog's sciatic, while in others the graft was of lesser size. At both ends of the graft in almost every instance a fibroneuroma would form. In some it was more marked at the proximal than at the distal end and in others the reverse. The size of the graft used bore no relationship to this phase. In one case it was impossible to determine from either gross or microscopical appearance where the graft was inserted so completely had it been incorporated in the tissues of the nerve itself. This dog had not regained function of the foot at the time it was sacrificed, but I believe would have produced a good result had the dog been allowed to live. In all of the other dogs the graft could be readily distinguished on gross appearance, although in many it was almost completely

surrounded by living connective tissue, yet there was enough of the dead graft left to identify it with the naked eye.

While we cannot agree with or even take seriously the bold conclusion drawn by Nageotte and Sencert that "we are in the right to say that not only the tissue which we have under our eyes is actually living, but that it is our dead graft itself which has become alive again"; but the statement "that we shall show how these dead heterogeneous nerve grafts are able to give functional results as good as autogenous grafts of equal long usage" seems the correct status. These men did not perform many operations and did not have the best of luck with some of their dogs. They drew their sweeping conclusions from only a few cases. In only one single instance of the experiments I have performed had the graft upon removal seemed alive, and in this instance the graft had been entirely replaced by new fibrous tissue. Even grossly it appeared in every other case to be dead. This is best noted grossly by removing it from the alcohol in which it had been placed and allowing it to become dry, when the dead portion becomes darker in color and loses entirely the glistening appearance of live tissue. Only those nerves which had been left in the dog for a long enough period for the graft to become wholly penetrated by the fibroblasts showed microscopically the appearance of live tissue. In but three instances did I find that the neuraxons grew primarily down through the graft; they usually were more abundant along the sides of the graft in the loose areolar and other surrounding connective tissue. The fibroneuroma which formed at the ends of the graft caused the production of much interlacing of the fibrillæ as they attempted to force their way through the scar. A longitudinal section through the whole graft and both ends of the nerve shows the fibrillæ parallel before entering the graft; then at the proximal end of the graft they are distorted as they try to penetrate the scar. After the graft is penetrated they again assume a parallel arrangement until they try to penetrate the distal scar, where the distortion or interlacing again is seen, but on entering the nerve proper the parallel arrangement is again assumed.

### CONCLUSIONS

First. The alcoholized grafted nerve dies.

Second. A great amount of fibrous tissue forms at both the proximal and distal ends of the graft, and regenerating neuraxons finding it difficult to penetrate this mass become more or less interlaced in the attempt and some will pass out into the loose connective tissue which route they prefer to the graft, or may become lost in the adjoining structures.

Third. While excellent functional results were obtained in one dog and no doubt in others we would have obtained like good results had the dogs not been sacrificed early, yet the percentage of successes would have been very small and the histological findings do not justify the conclusion that the alcoholized nerve graft should be one of choice.

Fourth. The regenerative power of nerves is so great that good results may often obtain not because of any particular method used but in spite of it.

Fifth. The ideal nerve graft has yet to be demonstrated.

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# ALCOHOL INJECTION IN ANGINA PECTORIS *

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AND

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FROM THE WEST SURGICAL SERVICE AND THE CARDIAC CLINIC OF THE MASSACHUSETTS GENERAL HOSPITAL

This paper is in the nature of a report of progress in the work we are doing at the Massachusetts General Hospital in the treatment of angina pectoris by paravertebral alcohol injection. As yet we have not enough cases to permit us to form any hard and fast conclusions concerning the method, but even though the study is not yet completed I believe it should have a place in this symposium on the surgery of the sympathetic nervous system. Five cases have already been reported by Dr. James C. White and Dr. Paul Dudley White.[1] To this we add four treatments together with a report as to the present condition of the five original cases.

About two years ago we became much interested in Swetlow[2] and Mandl's[3] reports of the treatment of angina pectoris by paravertebral injection, particularly as one of us (J. C. White) had recently taken up the subject of paravertebral anæsthesia in surgery using the technic advocated by Labat. Dr. Paul Dudley White, the head of the cardiac clinic at the Massachusetts General Hospital, was also greatly interested and with his coöperation it was decided to try out this method on a group of the most severe cases of angina that presented themselves at the clinic. We felt that this method, if successful, offered certain very definite advantages over the operative treatment of this disease. This treatment is based on the theory that the pain of angina is transmitted through the rami communicantes to the spinal nerve roots and thence to the brain, and that the greater part of these painful sensations are transmitted through the upper dorsal roots.

Swetlow[2] believes that the somatic representation of anginal pain on the surface of the body indicates the roots through which these painful sensations pass. We will not discuss this theory as it already has been fully elaborated by Mandl and Swetlow. We feel that this sensory pathway in anginal pain is fairly well established and our aim is to interrupt this pathway, thus stopping the pain of the anginal attack. As the greater part of this sensory pathway is through the first five dorsal roots, we have generally been content to inject these five. We have not tried to pick out certain roots for injection by means of the somatic distribution of the pain on the body surface.

Such a procedure as this of course does not eliminate the cause of the pain whatever that may be.

The technic used by us has been very similar to that used by Swetlow and is based on that of Labat[4] for paravertebral anæsthesia. The patient

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* Read before the American Surgical Association, May 1, 1928.

is placed on his side, the side to be injected uppermost. The back and neck are flexed and the spine kept level by a small pad under the short ribs and a pillow of the proper thickness. The skin is prepared with tincture of iodine which is washed off with alcohol. The seventh cervical and upper four dorsal spines are carefully located and marked on the skin with a small dot of acriflavin. Acriflavin used in this way after iodine gives a strong black mark which does not wash off easily.

A line is drawn with acriflavin 4 cm. from the spinous processes and parallel to them, and on this line crosses are made opposite each of the spinous processes previously marked. These crosses are the points of injection. Small dermal wheals are made with novocaine at each of these points. Five needles of a length of 8 to 10 cm. are used and are inserted as follows. The needle is inserted vertically to the skin of the back and pushed in until the rib is reached. The distance varies with the individual but is usually from 3 to 4 cm. Care must be taken not to go between the ribs and puncture the pleura. After the needle engages on the rib a little novocaine is injected and the needle is moved until it slips over the lower border of the rib. After the lower border is located the needle is withdrawn a few millimetres and its direction changed so that it points inward and toward the lower end of the spine at an angle of 45°. The needle is then advanced 2 cm. beyond the rib border. At this point it usually impinges on the vertebral body and should be correctly placed for injection. As its point is very close to the pleura the syringe is put on and aspiration attempted. If blood is drawn or a drop of pleural fluid the needle is withdrawn and reinserted. If not, 5 c.c. of 1 per cent. novocaine are cautiously injected. If the pleura has been injured this injection will cause coughing and the injection is stopped. The needle is left *in situ* and the next one is inserted. This is repeated until all five needles are placed and novocaine injected. Ten minutes is allowed to elapse. During this time a Horner's syndrome and anæsthesia of the skin of the chest wall will usually develop. Sometimes this will not take place. If there is no anæsthesia the result of the alcohol injection is somewhat doubtful. Five c.c. of 80 per cent. alcohol is next injected slowly through each needle. This injection usually causes some pain. If the pain is severe and increased by respiration, the injection through the needle should be stopped on account of the possibility of injury to the pleura. I think that I put a few drops of alcohol into the pleura in one case. The pain was very severe and markedly increased by respiration and for a short time I was much disturbed as to the outcome. It goes without saying that experience on the cadaver is of the greatest value. I do not believe that any one unless he has had a large experience in paravertebral anæsthesia should attempt alcohol injection in angina pectoris without experimental work on the cadaver.

Following injection there is a period of anæsthesia. As this wears off there may be a painful and annoying hyperæsthesia of the chest wall. In some of our cases this has lasted from 3 to 4 weeks. This in turn wears off and the patient is free from pain. If present the Horner's syndrome usually

persists for some time. There is usually a moderate rise in temperature lasting for 24 to 36 hours. Aside from one case in which there was severe pleural pain for a few hours, we have had no complications. The relief from the anginal attacks is immediate.

The five earlier injections were all done by Dr. James C. White and the work was taken up personally by me after his departure for Europe.

One of his patients who had been completely relieved of left-sided pain returned for relief of pain on the right side and he with three others complete the series.

All of these cases were carefully selected by Dr. Paul Dudley White as being the most severe or obstinate cases of angina pectoris coming to the clinic. None were refused on account of being too sick. All were totally unable to perform any kind of work, and several were having many attacks while at rest in bed. Several had had coronary thrombosis.

TABLE I.

*Angina Pectoris.*

| Case | Side | Attacks at rest | Coronary occlusion | Re- lieved | Duration in months |
|---|---|---|---|---|---|
| 1 | Left | + | — | 100 % | 14 |
| 1 | Right | — | — | 0 | 1 |
| 2 | Left | + | + | 50+% | 8* |
| 3 | Left | + | + | 10+% | 10 |
| 4 | Left | + | — | 100 % | 9 |
| 5 | Left | + | + | 25 % | 5* |
| 6 | Left | + | — | 90 % | 6 |
| 7 | Right | + | — | 65 % | 1½ |
| 8 | Left | + | + | .. | .. |

TABLE II.

*Angina Pectoris.*

| | |
|---|---|
| Treatments .......................................... | 9 |
| Relief 90% or over ... ............................. | 3 |
| Relief 35%–90% ..................................... | 3 |
| Relief less than 35% ................................ | 2 |
| Days in hospital .................................... | 2–3 |
| Deaths or serious complications .. .................... | 0 |
| Post-op. hyperæsthesia and pain ...................... | 7 |
| Since died ......................................... | 2 |

In all eight patients have been treated. One had two injections on the same side; one had first one side injected and later the other. The rest have had one side injected.

Table I shows the type of case selected for injection though only in a very general way.

Injections were made for left-sided pain seven times and for right-sided pain twice. All but one were having angina pectoris while at rest. Three

* Patient has since died.

had had coronary occlusion and one had coronary occlusion six weeks after treatment. The rest of the table is summarized in Table II.

Table II shows the results obtained to date in the series. As will be seen the injection gave over 90 per cent. relief on the side injected in three cases and partial relief in three. One case was practically a failure (No. 3). The left side was injected in Case 1 only a month ago. He has had considerable pain and marked hyperæsthesia which he believes is cardiac in origin. He does not consider that he has been benefited by this last injection. This injection must be classed as a failure at the present time. Case 8 is completely relieved to date (two weeks) but the time is too short to put him down as a successful case. It will be noted that following seven of these nine treatments there was troublesome pain and hyperæsthesia. This persisted in some instances up to five weeks and some of the patients were much discouraged at first as this pain is not relieved by nitroglycerin. The first patient was kept in hospital two weeks for observation but the others have only remained two or three days.

The fact that there have been no deaths and no serious complications as a result of the injections seems to indicate that the procedure is a fairly safe one. The fact that two patients have since died is not surprising considering the type of case treated, particularly as the only result sought is relief of pain.

We have not gone far enough as yet to know the group or groups of cases to which this form of treatment is most applicable. So far we have found that angina pectoris may be relieved in cases with or without a history of coronary thrombosis. Swetlow, in a recent personal communication, states that he has added eight cases to his series and that relief was obtained in six, all of them patients with coronary disease. Two cases of painful rheumatic heart showed no improvement after injection.

Speaking now for myself alone—I have been intensely interested in the progress of this work which has been carried out under my eye but in which I took no active part until Dr. James C. White went abroad. I have felt in the past that operations on the sympathetic nervous system for the relief of angina pectoris were difficult, dangerous and somewhat uncertain. Here is a form of treatment which is not so difficult after one has mastered the technic. It gives promise of being distinctly less dangerous and of giving results as good if not better than sympathectomy.

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# THE MORTALITY OF OPERATIONS UPON THE THYROID GLAND

## WITH AN ANALYSIS OF 388 OPERATIONS PERFORMED DURING 1927

### By Joseph L. DeCourcy, M.D.

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FROM THE DEPARTMENT OF SURGERY OF THE DECOURCY CLINIC

There are few branches of surgery in which such prodigious strides have been made during recent years as in the operative treatment of diseases of the thyroid gland. Samuel D. Gross[1] in 1866 maintained that, even when the size of the thyroid gland threatened to suffocate the patient, no honest and sensible surgeon would ever think of removing it. Some of us can still remember the time when the mortality from operations on the thyroid gland was almost prohibitive. When we consider that the mortality has now been reduced to a fraction of 1 per cent., we have much cause for satisfaction with the progress in this particular branch of surgery.

Charles H. Mayo[2] states that the mortality from operations on the thyroid gland at the Mayo Clinic compares favorably with that from any other major operation. He gives the mortality when computed by operations as 0.95 per cent.; when computed by cases, 1.2 per cent. He describes six diseases of the thyroid gland as being amenable to surgical treatment; namely (1) diffuse colloid goitre, (2) adenoma without hyperthyroidism, (3) adenoma with hyperthyroidism, (4) exophthalmic goitre, (5) thyroiditis and (6) malignancy. In adenoma without hyperthyroidism, he gives the surgical risk as less than 0.5 per cent., with a prospect of cure in practically 100 per cent. In adenoma with hyperthroidism, Mayo gives the mortality as between 2 and 4 per cent., with a prospect of cure in 83 per cent. and marked improvement in another 5 per cent. In exophthalmic goitre he estimates the surgical mortality as 1 per cent.; in terms of cases, 1.74 per cent.

In an analysis of his cases five years after operation, Mayo found that 90 per cent. of his patients were living, 79 per cent. considered themselves cured or greatly improved by the operation, 8 per cent. were improved but still showed evidences of hyperthyroidism or its effects, and 3 per cent. were not benefited by the operation.

In a series of 1,954 goitre operations in the Mayo Clinic reported by Pemberton[3] in 1922, including 1,853 partial thyroidectomies, thirty-five patients died, a mortality of 1.78 per cent. The deaths were due to three main causes: namely (1) accidental causes, in three patients; (2) severe hyperthyroidism, in seven patients; and (3) moderate hyperthyroidism plus pulmonary complications due to lowered resistance, in twelve patients. Pemberton stressed the importance of a proper selection of cases for operation. If poorer surgical risks are accepted, a higher mortality rate is unavoidable.

In a later communication Pemberton[4] pointed out that the mortality rate following surgical procedures on patients with exophthalmic goitre has been reduced to 1 per cent. in terms of operations and 1.73 per cent. in terms of patients. In his experience, patients with visceral degenerative changes form the largest part of the mortality list in the surgery of exophthalmic goitre. When the patient comes from operation early in the disease, before degenerative changes have taken place, the operative risk is much less and the likelihood of cure proportionately greater. Pemberton attaches great importance to painstaking attention to details as a means of preventing post-operative complications in cases of exophthalmic goitre.

According to Pemberton,[5] there were 1,928 operations upon 1,725 patients with goitre at the Mayo Clinic during 1924. Ten patients died, giving a mortality of 0.51 per cent. by operation and 0.58 by case. There were no deaths in the group of 677 patients who had goitres unassociated with hyperthyroidism; in 368 patients with hyperfunctioning adenomatous goitre, there were four deaths (1.08 per cent.); in 741 with exophthalmic goitre, six deaths (0.8 per cent.). Pemberton rightly ascribes the extremely low mortality rate achieved by the present-day surgical treatment of diseases of the thyroid gland to the perfection of operative technic and the discovery of means of controlling crises of hyperthyroidism.

*Other Mortality Statistics.*—While the statistics of the clinics which have devoted much time and attention to goitre work are naturally the most favorable, there has been a commendable fall in the mortality rates of experienced surgeons everywhere who are doing a large number of goitre operations.

Dowd[6] in 1924 reported the end results of 150 operations for goitre. Five patients died in the hospital and four more since leaving the hospital. One hundred and three enjoyed good health and were able to do an ordinary amount of work. Dowd observed so many failures from röntgen-ray and medicinal treatment that he believes surgery to be the best treatment for a large proportion of patients with goitre.

In a series of 923 operations for goitre, Joyce[7] in 1926 reported twenty-two deaths, a mortality of 2.3 per cent. The series included 851 thyroidectomies with a mortality of 1.9 per cent., and seventy-two ligations with a mortality of 7 per cent. For resections in exophthalmic goitre the mortality was 2.4 per cent.; in toxic adenoma, 1.8 per cent.

Clute[8] has emphasized the part that the pre-operative use of iodine solution may play in the surgical treatment. Before using iodine solution, he operated upon only 38 per cent. of his patients in one stage; after employing this measure, upon 63.7 per cent.

In a series of 2,200 operations for simple goitre, de Quervain[9] in 1924 reported a mortality of 0.84 per cent. In 1,682 operations upon patients under forty, there was only one death. As would be expected, the mortality rose with the age. In the fifth decade, it was 1 per cent.; in the sixth, 4.1 per cent.; in the seventh, almost 20 per cent.; and in patients over seventy, 25 per cent.

In forty-six operative cases of goitre reported by de Planque[10] in 1924, there were four deaths. Only half of the thyroid gland was removed in each case. Only seven of the seventeen patients with exophthalmic goitre and nineteen of the twenty-nine with non-toxic goitres were cured by the operation. De Planque has now adopted subtotal thyroidectomy as a routine procedure.

Sandelin[11] in 1925 reported a series of 268 thyroidectomies with five deaths. In his work he did a bilateral one-stage thyroidectomy under ether. He did not ligate the inferior thyroid artery, thus saving time and avoiding the risk of injury to the recurrent laryngeal nerve and the parathyroid bodies.

Prat[12] in 1925 described thirty-four cases in which partial thyroidectomy was performed for exophthalmic goitre. Commenting on the low death rate, he maintained that physicians should no longer cling to medical treatment if there is no manifest improvement. Almost 80 per cent. of his patients were completely or nearly cured by the operation.

Troell[13] in 1925 reported seven deaths in connection with the thyroid operation under general anæsthesia in a series of fifty-six cases of toxic goitre. The anæsthesia may have been partially responsible for this relatively high mortality.

During the year 1927, 936 patients with goitres presented themselves at the DeCourcy Clinic or the out-patient goitre department of the Good Samaritan Hospital, 388 of whom submitted to operation. Cases in which there were hyperplastic or adenomatous goitres constituted the great majority

of the operative group. In 92 per cent. of the operative cases, the goitre was in a toxic state. For the most part, the patients who were not subjected to operation were adolescent girls with colloid goitres. However, the surgical group included, in addition to hyperplastic (exophthalmic) and adenomatous goitres, colloid goitres in persons past twenty-one who did not progress favorably after three months of medical treatment, malignant growths and thyroiditis. During this entire series of operations there were no ligations; both lobes of the thyroid gland were removed in every instance.

*Preparation for Operation.*—In the colloid cases very little preparation was required and the average stay in the hospital was only four days. Preparation for operation in the case of adenomata depended on the degree of toxicity and cardiac instability. In mildly toxic cases there was no special preparation. In severely toxic adenomatous goitres with cardiac instability or decompensation the patients were placed in bed in the hospital and given a course of digitalis therapy. If there was neither irregularity of the heart beat nor decompensation, three doses of a standardized tincture of digitalis of 30 minims each were given at intervals of eight hours. The purpose of this preparation was to furnish the heart with enough assistance to enable it to withstand the reaction following operation. When cardiac arrhythmia was present with or without decompensation, ten drops of tincture of digitalis were given three times a day until compensation was restored. This result generally required from five to seven days. As a rule the digitalis was discontinued about five days before operation but resumed immediately afterward. When there was any considerable instability of the heart, it was given in the form of one ampoule of digifoline every four hours, beginning immediately after the operation. In a few cases, the arrhythmia did not cease in spite of the preliminary digitalization; yet thyroidectomy was performed and the cardiac irregularity in no way interfered with the operative result.

Elsewhere I[14] have referred to the fact that the most important presage of circulatory failure in exophthalmic goitre is the beginning of cardiac irregularities. In this condition, it will be recalled, the vascular changes are similar to those of aortic regurgitation, although less in degree. It is for this reason that I believe that the preparation for operation should include a most careful check-up on the condition of the heart and digitalization whenever cardiac irregularities are found or appear likely to develop. I agree with Richter[15] that cardiac decompensation and auricular fibrillation may cause delay but do not really constitute a contraindication to surgery. To quote Richter, "Nothing is to be hoped for in such cases in the presence of continuous thyrotoxicosis; nothing in surgery is more brilliant than their recovery after adequate thyroidectomy."

*Use of Lugol's Solution.*—In cases of hyperplastic and adenomatous goitre I have adopted the routine practice of using Lugol's solution both before and after operation. While iodine gives only temporary benefit in toxic goitre, it possesses the very great advantage of allowing the surgeon

to operate exactly at the time when the patient is enjoying a remission from his disease, as it were. And I believe that it is to this type of preparation and a careful technic involving the absolue minimum of surgical trauma that the low mortality rates encountered in the larger surgical clinics during the last few years are due.

In an earlier communication I[16] offered an explanation for the temporary benefit following the use of Lugol's solution in cases of toxic goitre. During the course of my work on hyperplastic goitres in patients subjected to preliminary iodine treatment I have repeatedly observed that the gland at operation is extremely œdematous. When it is sectioned, water exudes freely from the cut surfaces. In patients who have not received Lugol's solution preparatory to operation, on the contrary, this condition is not observed.

The foregoing observations have led me to believe that the beneficial influence of Lugol's solution in cases of toxic goitre is brought about by a rapid formation of colloid material in the iodine-famished gland, the result of which is a back pressure on the secretory cells and thin-walled veins · surrounding the acini. This condition causes passive œdema, as a result of which the cells, temporarily rendered inactive, fail to absorb the toxic substance. That is the probable reason why the clinical condition of the patient improves. Eventually, however, new blood vessels are formed in response to the changed conditions. Then absorption is resumed and the goitre again becomes toxic. This theory would also serve to explain why improvement is slower and less noticeable in long-standing cases, since a deposition of fibrous connective tissue around the acini prevents them from becoming overdistended with colloid material.

My practice in cases of hyperplastic and adenomatous goitre has been to administer ten drops of Lugol's solution three times a day for from two to four weeks, depending upon the degree of clinical improvement and the change in the gland itself, as checked by metabolic readings. Improvement following the administration of Lugol's solution is not uniform. In early untreated cases, although many of them were very severe, the results of iodine medication were excellent and dependable. In cases of long standing, on the contrary, the action of Lugol's solution was not so satisfactory. The effects upon the gland itself were less noticeable, improvement was much slower, and the ultimate therapeutic results were in no way comparable with those observed in cases of shorter duration. When Lugol's solution had previously been given but toxic symptoms had returned after a temporary remission, it was frequently found that the symptoms abated and the metabolic rate fell on a régime of complete rest with iodine medication.

In uncomplicated and non-toxic cases, patients under iodine medication were not put to bed but encouraged to keep up and about. One patient whom I saw in consultation with another surgeon began to improve immediately she was allowed out of bed. Particularly noticeable was the improvement in her appetite.

In all toxic cases after operation I give about 30 minims of Lugol's solution, as required, usually repeating the dose in about eight hours. In severe cases of exophthalmic goitre, a third dose may be required; but this is seldom the case when the patient has been prepared properly.

*Advantages of Open Wound.*—In toxic cases showing evidence of myocardial instability it was our policy to allow the wound to remain open for forty-eight hours. This procedure, it was found, diminishes the reaction and consequently lessens the strain placed upon the heart. For example, in cases of severely toxic adenomatous goitre in which our past experience would lead us ordinarily to expect a post-operative temperature of 103° F., we generally observed a temperature between 100° and 101°—sometimes below 100°—when the wound was allowed to remain open for forty-eight hours after operation. I feel that this is a factor of material importance in avoiding a considerable percentage of post-operative deaths.

*Complications.*—In this entire series of 388 operations, 92 per cent. of them upon patients with toxic goitre, there was but one death. This makes our mortality for the year 1927 only .0025 per cent., a notable improvement over the statistics of several years ago.

Our only death occurred in a patient with exophthalmic goitre, who received preparation with Lugol's solution and was apparently in good condition at the time of operation, when the metabolic rate was plus 19. Beginning eight hours after the operation, there was a severe reaction. The temperature rose to 107° F. and the pulse was so rapid that it could not be counted. Ice packs failed to check the reaction and death took place fourteen hours after operation. In this case Lugol's solution was not used post-operatively. Whether or not its prompt use after the operation would have prevented the fatal issue we cannot say.

In six of our cases the goitrous condition was complicated by diabetes mellitus. All of these patients had hyperplastic goitres, and they were prepared for operation with the routine Lugol's solution, plus insulin and a restricted carbohydrate diet until their urine became sugar-free. In these cases operation was performed without difficulty and convalescence was uneventful. Even when insulin was withdrawn and greater liberality in the diet allowed, glycosuria did not return. Of course, the diabetic condition was probably still present; but the removal of the hyperplastic thyroid gland had undoubtedly effected an improvement in the tolerance for sugar.

## CONCLUSIONS

1. During recent years there has been a notable drop in the mortality from operations on the thyroid gland, a procedure which once resulted in a prohibitive death rate. The mortality is now held to be only about 1 per cent.

2. At the DeCourcy Clinic there were 388 operations on the thyroid gland during 1927, with only one death, a mortality rate of only .0025 per cent.

3. The most important factors in bringing about the lower mortality

from goitre operations have been improved surgical technic and the more careful pre-operative and post-operative care of the patient, particularly the use of Lugol's solution and digitalis.

4. When the operative wound is allowed to remain open for forty-eight hours, the likelihood of high post-operative fever is greatly diminished.

5. Patients with diabetes mellitus, when properly prepared, may be subjected to thyroidectomy without danger, and usually with considerable benefit.

6. Lugol's solution brings about a remission from the symptoms of exophthalmic goitre, probably by causing great œdema of the thyroid gland, due to distention of the acini with colloid material. This œdema presumably interferes with the absorption of toxic substances from the gland.

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# PERFORATION OF PEPTIC ULCER *

## OBSERVATION OF ONE HUNDRED CASES AT THE PENNSYLVANIA AND PRESBYTERIAN HOSPITALS

### By HENRY P. BROWN, JR., M.D.

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ACUTE perforation of peptic ulcer has presented a problem of interest to surgeons for many years, and in view of the already voluminous literature on the subject, it is with a feeling somewhat of temerity that we present this paper, especially as we fully appreciate that it contains nothing new.

With the thought that it might be of interest to review those treated at the Pennsylvania and Presbyterian hospitals in recent years, we have examined the records of sixty-six cases at the former, from 1910 to 1928; and thirty-four at the latter, from 1920 to 1928, each having been operated upon and the diagnosis of perforation confirmed.

During this period there were admitted to the Pennsylvania Hospital 637 cases, and to the Presbyterian Hospital 243, a total of 880, in which the diagnosis of peptic ulcer was made.

For the privilege of reporting this series I am indebted to Doctors Gibbon and Mitchell, at the Pennsylvania; and Doctors Jopson, Hodge and Speese, at the Presbyterian; and the former chiefs at both institutions, upon whose services the cases were admitted.

Operation for perforation usually requiring emergency treatment, the vast majority were performed by the members of the junior staffs who handle such cases. This fact should be borne in mind in discussing the operative procedure adopted. The results are, therefore, fairly representative of what may be expected in two such general hospitals.

Two patients were under twenty years of age (Table I), twenty-six were

### TABLE I

*Table Showing Age of Patients*

| Under 20 | 20–29 | 30–39 | 40–49 | 50–59 | Over 60 | Not stated |
|----------|-------|-------|-------|-------|---------|------------|
| 2 | 26 | 27 | 17 | 17 | 7 | 4 |

between twenty and thirty, twenty-seven between thirty and forty, from which time the incidence decreased, seven being over sixty years of age.

We were rather surprised at the preponderance of the condition in males, it having occurred only five times in women. This is in accord with other observers, the proportion of males, however, being somewhat higher than in many of the recorded series.

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* Read before the Philadelphia Academy of Surgery, November 5, 1928.

Just why the colored race should have a considerably lower percentage of perforation is not clear, only ten cases having been encountered.

A discussion of the etiology of peptic ulcers and their perforations would lead one far afield and is not within the scope of this paper, nor is it our intention to dwell, except very briefly, on the question of symptomatology and differential diagnosis. Those interested in these aspects of the subject are referred to the many excellent articles dealing therewith. Sufficient to say that abdominal pain, either upper or generalized, with or without vomiting, was recorded as the chief complaint ninety-five times, and one patient had symptoms confined to the region of the left kidney. Six gave a history of hæmatemesis, two had melina, and two noted both symptoms in addition to the abdominal pain.

About one-half of the entire group had been for various periods under more or less irregular medical observation for "stomach trouble", and of these, only eight had regarded themselves as being improved, and none, as cured of their complaint.

In making a differential diagnosis, among the conditions most frequently encountered, one must consider the possibility of acute appendicitis; acute cholecystitis (with or without stone); acute pancreatitis; thoracic infections; mesenteric embolus; tabetic crises; volvulus; intestinal obstruction, and other less frequently encountered conditions. A mistaken diagnosis of acute appendicitis was made seven times; acute cholecystitis five times; intestinal obstruction in three, and acute pancreatitis in two instances.

The fact that all cases of acute perforation do not present acute symptoms was exemplified by a colored man, of thirty-five years, who was admitted to the Pennsylvania Hospital complaining of moderate abdominal pain. He had been having occasional attacks of indigestion for the preceding four years, and on the day of admission had a rather severe exacerbation of his previous symptoms. On admission he showed a pulse rate of eighty-four and sub-normal temperature, lay quietly in bed, was not shocked, and while there was some upper abdominal tenderness, there was no marked rigidity. He was seen by one of the junior members of the staff and held for observation. Next day the tenderness had increased somewhat, there was moderate abdominal rigidity, peristalsis was audible but sluggish, and the liver dulness was not obliterated. Exploration was advised on the strength of his history and physical signs and revealed a perforated callous duodenal ulcer, with widespread fluid in his abdomen. A simple closure and drainage was done and he made an uninterrupted recovery.

In this connection it was noted that on admission (Table II) sixty-four patients were in a condition of shock and presented a rigid abdomen; twenty-two had rigidity without shock; two were in a condition of shock but had no rigidity, and in five the notes state that they presented neither shock nor rigidity.

A colored man of thirty-five years was treated in the medical wards and discharged at the end of twenty-eight days, the diagnosis being abdominal

angina. He was readmitted three weeks later with symptoms of a perforation and immediate exploration revealed a perforation of a callous gastric ulcer with his abdomen full of gastric contents. He died.

TABLE II

*Table Showing Condition of Patients on Admission*

| Shock and rigid | Not shock—rigid | Shock—not rigid | Not shock—not rigid | Not stated |
|---|---|---|---|---|
| 64 | 22 | 2 | 5 | 7 |

These observations merely stress the importance of being on the lookout for cases presenting atypical symptoms.

In 79 per cent. of the cases, the pre-operative diagnosis of perforated ulcer was correct, but this of course does not take into consideration those instances where exploration revealed such a pre-operative diagnosis to have been wrong. This percentage is lower than that reported by Brenner[1]—91 per cent. correct diagnosis in twenty-four acute cases. We believe, however, that the important factor is the recognition of the fact that the patient has an acute abdomen requiring immediate exploration, and that one should not delay operation in an endeavor to make a correct diagnosis.

Very little need be said about the importance of early surgery in cases of acute perforation. In this series, of fifty-four cases seen within twelve hours, fourteen died (Table III), a mortality of 28 per cent., 27 per cent. in Stenbuck's[2] series of fifty-three. Fourteen patients were operated upon between twelve and twenty-four hours, eight of whom died, a mortality of 57 per cent. One patient with a history of perforation six days previous to operation, and another of seven days' duration, each lived, exploration revealing a partially walled off localization of the perforation.

In thirteen instances the patients gave a definite history of prodromal symptoms previous to perforation, as evidence by a marked increase of their former trouble. Eight of these cases died. Table III shows the duration of chronic symptoms, and it is of interest to note that in ten instances the patients were sure that they had been free of symptoms previous to the time of their perforation. Four patients had previously had an appendectomy and two had been operated upon for peptic ulcer, one of the latter being a perforation.

*Anæsthesia.*—Nitrous oxide-oxygen, usually with sufficient ether for relaxation, was the anæsthetic of choice in the vast majority of instances. It is our personal feeling that in these cases, this combination, when properly administered, more nearly approaches the ideal than any other method. Many of the operations, starting as local, end with a general anæsthetic, and we feel that the time spent in administration of local measures is therefore largely wasted. Frequently these patients are poor surgical risks and operative speed is a prime requisite. Muscular relaxation being one of the important factors

TABLE III

Table Showing Duration of Acute and Chronic Symptoms before Operation, with Outcome

| Duration of acute symptoms before operation | | Chronic symptoms | | | | | | | | | | | | | | | | | | | | | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | None | Weeks | | | | Months | | | | | | | | | | Years | | | | | | | |
| | | | 1 | 2 | 3 | 4 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 | 4 | 5 | Over 5 | | |
| Under 12 hrs. | L* | 7 | 5 | 1 | 1 | 1 | 2 | 1 | | | 2 | | 1 | | | | 2 | 3 | 4 | 5 | 2 | 10 | 4 | 51 |
| | D† | 2 | 1 | 1 | 2 | | | | | | | | | | | | 2 | 1 | 1 | | | 4 | 1 | 14 |
| 12 to 24 | L. | | | 1 | | | | | | | | | 1 | | | | | 1 | | 1 | | 1 | 1 | 6 |
| | D. | | | 1 | | | | | 1 | | | | | | | | | 1 | 3 | 1 | | 1 | | 8 |
| 24 to 36 | L. | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| | D. | | 1 | | | | | | | | | | | | | | | | | 1 | | 1 | 1 | 4 |
| 36 to 48 | L. | | | 1 | | | 1 | | | | 1 | | | | | | | | | | | 1 | | 3 |
| | D. | 1 | | | | | | | | | | | | | | | | | | | | 1 | | 2 |
| 2½ Days | L. | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| 3 Days | L. | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| 4 Days | L. | | | | 1 | | | | | | | | | | | | 1 | | | | | | | 2 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| 5 Days | L. | | | | | | | | | | | | | | | | | 1 | | | | | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| 6 Days | L. | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| 7 Days | L. | | | | | | | | | | | | 1 | | | | | | | | | | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |
| Over. | L. | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| | D. | | | | | | | | | | | | | | | | | | | | | | | |

*L.—Lived.
†D.—Died.

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in this connection, it has been our experience that this can be most satisfactorily obtained by the use of nitrous oxide-oxygen.

The chief objection to a general anæsthetic is of course pulmonary complications. Six patients developed pneumonia and died.

We fully realize that many surgeons condemn any form of general narcosis in these cases, and if they or their assistants are adept in the use of para-vertebral, intraspinal or other methods of administration, they have all the more reason for favoring their use. It has, however, been our experience in general major abdominal operations, using one or a combination of the various forms of local anæsthesia, that pulmonary complications are by no means avoided. We feel, therefore, that unless one has had extensive experience in the use of local methods, it is usually better for both surgeon and patient to use a general anæsthetic when dealing with acute peptic perforations.

We are in accord with the majority of surgeons who have written on the subject that the diagnosis of perforation is an indication for immediate operation regardless of the patient's condition. Four cases, however, not included in this series, with histories and signs typical of perforation, were so near death on admission that it was evident operation *per se* would be fatal. With the exception of these fatalities, all other cases were explored soon after the diagnosis of perforation was made.

*Operative Procedure.*—One of the moot points which will probably never receive unanimous support, is whether operative measures should be limited to merely closing the perforation, with or without excision of the ulcer, or whether a gastro-enterostomy should be added, there being very few writers as yet who advocate a partial gastrectomy at this stage.

Should one be fortunate enough to explore a duodenal or pyloric ulcer within a few hours preceding its perforation, the patient being in good condition, we believe that few surgeons would be content with merely local treatment of the ulcer. From their recorded observations most operators prefer, in addition to some form of excision, cautery puncture or simple invagination, a gastro-enterostomy, pyloroplasty or other procedure. It therefore seems illogical to us that the mere fact of the ulcer having perforated should so change the underlying pathology as to render unnecessary any measure other than simple excision or closure, providing, of course, that the patient's condition is such as to warrant a gastro-enterostomy or pyloroplasty being done.

A colored man of twenty-eight years, who stated that he had always suffered from indigestion, was operated upon five years previously for a perforated appendix. Two years later he had a simple closure done for a perforated duodenal ulcer, and he had relief for the next three years till the day of admission. At this time he made his own diagnosis of perforation, and exploration revealed a partially walled off perforation in the centre of an old duodenal ulcer. The ulcer was closed and a posterior gastro-enterostomy was done. On the nineteenth post-operative day pus was aspirated from the

eighth costal interspace posterior axillary line; his abdominal condition apparently cleared up but he gradually sank and died on the twenty-fifth post-operative day.

A comparison of the mortality of those cases in which gastro-enterostomy was not done (seventy-two cases with twenty-five deaths—39 per cent.) with those in which this method was adopted (twenty-eight cases with eight deaths—29 per cent.) is of little value, for it fails to take into consideration the condition of the patient at the time of operation. In the latter group, in which gastro-enterostomy was done, pneumonia and myocarditis were each responsible for one fatality and peritonitis for the remainder. The extra time required for adding the gastro-enterostomy apparently did not influence the outcome (Table IV), and we feel that this argument cannot be used against its adoption.

TABLE IV

*Table Showing Duration and Type of Operation with Outcome**

| | Minutes | | | | | | | | Hours | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 20 | | 30 | | 45 | | 60 | | 1¼ | | 1½ | | 1¾ | | Over | |
| | L.† | D.‡ | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. |
| Simple closure.......... | 5 | 5 | 14 | 9 | 12 | 7 | 6 | 3 | 4 | | 2 | 1 | | | | |
| Closure plus gastro-enterostomy............... | | | | | 2 | 1 | 2 | 1 | 9 | 2 | 2 | 1 | 4 | | 1 | |

* 7 cases not stated as to time.
† L.—Lived.
‡ D.—Died.

Judging from the follow-up records of other writers, excellent results have been obtained when the simpler method was used, and we regret exceedingly that the follow-up systems at the Pennsylvania and Presbyterian hospitals did not enable us to reach a sufficient number of these patients to make their recording worth while. We realize that this omission in itself greatly vitiates the value of our observations, but, in spite of this failure, we are of the opinion that if the patient's condition warrants it, and the technical difficulties are not a contraindication, closure of the perforation, or excision and closure, plus posterior gastro-enterostomy is the method of choice.

When it can be done we feel that the appendix should be removed coincident with the treatment of the perforation, and this seems all the more important when it is so situated, from adhesions or otherwise, that its removal adds somewhat to the technical difficulties.

*Drainage.*—Where it was noted that the perforation was either walled off from the general peritoneal cavity, or the latter was not grossly contaminated —twenty cases—drainage was omitted seven times with two deaths, each from peritonitis. In those cases, eighty in number, in which the peritoneum was widely involved, after removing as much as possible of the contaminat-

ing material, the abdomen was closed without drainage eight times. Two in this group of eight died.

While it may not always be necessary to institute drainage following a perforation, depending upon the extent and type of involvement of the peritoneal cavity, yet we have never seen any ill result which could be attributed to its use. We prefer a cigarette drain placed in the pelvis, through a separate stab wound in the lower abdomen, and should peritonitis not occur it can be removed at the end of forty-eight hours. The recollection of a few instances is still quite vivid in which drainage was not considered necessary, but was done, and subsequent developments made us very thankful that this procedure had been adopted. In the great majority of cases the drain was removed on or before the end of the second day, which fact tends in itself to prove that it was not necessary.

*Complications.*—Peritonitis, either local or widespread, was, of course, present to a variable degree in each case but was not recorded as such unless it persisted and gave rise to symptoms beyond the second post-operative day. Twenty-four patients developing this complication died, while eighteen survived. Table V shows how frequently this condition was encountered in the various types of ulcer; whether or not the abdomen was drained; the type of operation done; whether or not the perforation was walled off, and the mortality in each group.

Subphrenic abscess as such, giving rise to symptoms several days after operation, was only encountered once. A white man of fifty-one years, with a twelve-hour perforation of a duodenal ulcer which had been giving rise to symptoms for two weeks previously, had a simple closure and drainage operation done, peritonitis being widespread. On the twenty-second post-operative day laparotomy was again done for intestinal obstruction—small bowel to hepatic colon. On the thirty-third day following the original operation symptoms of intestinal obstruction again developed, and at operation, in attempting to free the adhesions, the small bowel was twice ruptured and closed. On the sixty-fourth post-operative day he developed a subphrenic abscess which was later opened and drained and he made a good recovery. A collection in the subphrenic region may of course have existed in those cases dying of peritonitis, but if so, it was not recognized as such. Whether or not this low incidence of subphrenic abscess was due to the fact that only in very few instances was the upper abdomen drained, as advanced by Mills[3] we do not know.

Two patients developed empyema subsequent to pneumonia. Two patients eviscerated a large part of their intestinal tracts following violent coughing attacks, one of them having a gastric hæmorrhage in addition. We cite these latter cases as a plea for the use of strong catgut in closing the peritoneal cavity, especially when the latter is infected.

There was a mortality of 33 per cent. for the series as a whole (46 per cent. Dunbar.[4] 31 per cent. Stenbuck,[2] 27 per cent. Mills,[3] 18.6 per cent. Gibson[5]).

TABLE V

*Table Showing Whether Perforation Was Walled Off from Abdominal Cavity; Type of Operation; Whether Drainage Was Used; Whether Peritonitis Developed and Outcome of Case*

| Location of Ulcer | Perforation walled off | | | | | | | | | | | | | | | | Perforation not walled off (free) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Simple closure | | | | | | | | Closure and gastro-enterostomy | | | | | | | | Simple closure | | | | | | | | Closure and gastro-enterostomy | | | | | | | |
| | Drain | | | | Not drained | | | | Drain | | | | Not drained | | | | Drain | | | | Not drained | | | | Drain | | | | Not drained | | | |
| | Peri't later | | Not peri't later | | Peri't later | | Not peri't later | | Peri't later | | Not peri't later | | Peri't later | | Not peri't later | | Peri't later | | Not Peri't later | | Peri't later | | Not peri't later | | Peri't later | | Not peri't later | | Peri't later | | Not peri't later | |
| | *L. | †D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. | L. | D. |
| Duodenal | 1 | | 2 | 2 | | | 1 | | 1 | | 1 | 1 | | | 2 | | 6 | 3 | 15 | | | 1 | 2 | | 2 | 3 | 3 | 2 | | | 3 | |
| Pyloric | | | 1 | 1 | | | | | | | | | | | 1 | | 1 | 3 | 1 | 1 | | | | | | | 3 | | | | | |
| Gastric | | | 2 | | | | | | | | | | 1 | | 1 | 1 | 5 | 11 | 8 | 2 | | | 1 | | 1 | | 2 | | | | | 1 |
| Total | 1 | | 5 | 3 | | | 1 | | 1 | | 1 | 1 | 1 | | 4 | 1 | 12 | 17 | 24 | 3 | | 1 | 3 | | 3 | 3 | 8 | 2 | | | 3 | 1 |

* L.—Lived
† D.—Died
‡ Peri't—Peritonitis

Table VI shows the interval between operation and death, with causes for the same. The greatest mortality occurred within the first twelve post-operative hours and was ascribed to peritonitis with its associated shock.

TABLE VI

*Interval Between Operation and Death, with Cause of Same*

| | Hours | | Days | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under 12 | 12–24 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Over | |
| Peritonitis | | | 1 | 2 | 1 | 1 | 1 | | | | | | | | | | 6 |
| Shock and Peritonitis | 8 | | 3 | | | | | | | | | | | | | | 11 |
| Peritonitis and Pneumonia | | | | 1 | 1 | | | | 1 | | | | | | | | 3 |
| Peritonitis, Pneumonia and Empyema | | | | | | | | | | | | | | | | 1 | 1 |
| Peritonitis and Evisceration | | | | | | | | | | | | | 1 | | | 1 | 2 |
| Peritonitis and Alcoholism | | | | 1 | | | | | | | | | | | | | 1 |
| Pneumonia | | | | | 1 | 1 | 1 | | | | | 1 | | | | | 4 |
| Lung abscess | | | | | | | | | | | | | | 1 | | | 1 |
| Post-operative hæmorrhage | | | | | | | | | | | | | | | 1 | | 1 |
| Cardiac—Toxemia | | | | | | | 1 | | | | | | | | | 2 | 3 |

The pulmonary fatalities appeared from the fourth to the sixth day, while the abscess complications were manifest after the second week. This agrees in the main with Stenbuck's observation except that peritonitis falls in an earlier period.

CONCLUSIONS

This series is of course too small to warrant any conclusions of value, and, as was stated at the outset, nothing new has been presented. Our impressions from a study of the group are:

1. Operation should be performed as soon as possible in all cases in which the diagnosis of perforated ulcer has been made, unless the patient is obviously in a moribund condition. Should exploration show that an incorrect diagnosis has been made, the condition revealed will in nearly all cases be one which would have required urgent surgical interference.

2. Nitrous oxide-oxygen is the anæsthetic of choice unless the surgeon has a strong preference for some form of local administration.

3. If the patient's condition warrants it and the operator's technic is proficient, closure, excision or cauterization of the ulcer, plus gastro-enterostomy or pyloroplasty, is the method of choice, this however being an open question.

4. It is safest to institute drainage of the lower abdomen for forty-eight hours in all except definitely walled-off perforations.

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# MESENTERIC INJURIES AND INTESTINAL VIABILITY

## By Thomas Creasy Bost, M.D.

### of Charlotte, N. C.

In penetrating wounds of the abdomen, injury to the mesentery is one of the most common and serious lesions encountered. Hæmorrhage itself may be fatal from injured mesenteric vessels; slits in the mesentery lead to hernia; but aside from this what especially should be emphasized is that mesenteric injuries are of importance in proportion to the extent to which the integrity of the blood supply to a given intestinal loop is compromised. So that a mesenteric injury cannot be considered as a clinical entity but as an intestinal injury as well.

In addition to injuries resulting from trauma of the mesentery, we have also to consider the surgical removal of cysts and tumors of the mesentery, as their removal may affect the viability of an intestinal loop. Therefore in dealing surgically with traumatic injuries and new growths of the mesentery, it is necessary to arrive at a rather definite conclusion as to how much of the blood supply can be sacrificed and yet leave the affected loop viable. Failure to resect a loop of intestine incapable of regaining its vitality would be disastrous, while doing unnecessarily a resection would also give a tremendous increase in mortality, especially in traumatic injuries, as other organs are frequently injured at the same time, making such a case a very poor surgical risk. So that in a border-line case severely shocked it would probably be better not to do a resection.

Warbasse[1] says wounds parallel to the bowel, if they cross one or two large vessels, require resection of the bowel, and that simple suture of wounds of the mesentery is not much called for because wounds large enough to require suturing are apt to have done so much damage to the vessels as to demand more radical treatment.

Da Costa[2] says if branches of the superior mesenteric artery are divided near the bowel, gangrene of the bowel will result, but wounds of a branch far from the intestine do not cause gangrene. If the wound is found close to the gut, the portion of the gut supplied by the cut vessel should be resected.

Fowler[3] says that if more than an inch or so of mesentery is torn from an intestine, a resection should be done.
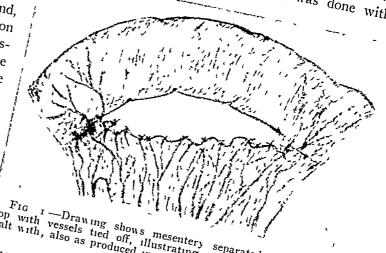
Surgical teaching would seem to fix a mesenteric tear of about two inches at its intestinal attachment as being the border line; that is, greater lengths would require resection while shorter lengths would only require suturing.

The clinical cases herewith reported, supplemented by some experimental work that I have since done, would tend to show that a much more extensive sacrifice of the blood supply can be tolerated without the necessity of a resection.

## EXPERIMENTAL WORK

CASE I.—White man, age thirty-six, was shot in the abdomen with a thirty-eight-calibre pistol and was admitted to the hospital in a marked state of shock with severe abdominal pain and with general board-like rigidity. A laparotomy was done within three hours of the accident.

There was a large quantity of blood in the abdomen. Nine perforations were found, two in the transverse colon and seven in the small intestine. The perforations were closed in the usual way. The bullet ranged along the mesenteric attachment, severing the blood supply to an intestinal loop, for four inches. The bleeding vessels were ligated and the mesentery sutured to the intestine. The omentum was then tucked around this intestinal loop and tacked. No resection was done.



FIG. 1.—Drawing shows mesentery separated from intestinal loop with vessels tied off, illustrating condition in clinical cases dealt with, also as produced in experimental cases

ery and is now in good health, five years after operation. Patient made a good recovery. A drain was put in

CASE II.—White man, age sixty-six, dairyman; was severely gored by a bull July 28, 1921. The abdomen was torn open and a number of coils of small intestine were dragged and forced out of the abdomen. The man was then wallowed about in the farmyard before he could be rescued. A large bath towel was pinned around him to support the extruded intestinal loops, and the patient was taken to St. Peter's Hospital, where I first saw him
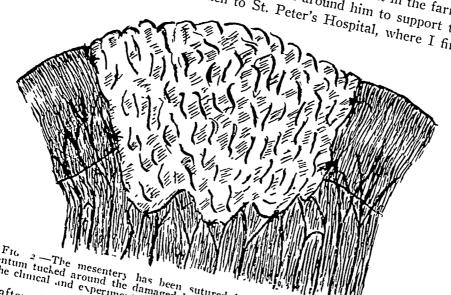


FIG. 2.—The mesentery has been sutured back to the intestine and the omentum tucked around the damaged loop and tacked in position as was done in the clinical and experimental cases

several hours after the accident. He was in a marked state of shock, with coils of intestine still outside and there was hæmorrhage from the wound. Treatment to combat shock was immediately instituted, followed by operation. There was a large irregular wound three and one-half by five inches through the right rectus muscle about the level of the umbilicus. This wound was excised and enlarged, whereupon the abdomen was found to have a large quantity of free blood. Hæmorrhage was still in progress from torn mesenteric vessels. The horn had passed through the base of the mesentery and

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ranged upward along the aorta, stripping off the peritoneum and loosening the head of the pancreas and duodenum. The mesentery was torn loose from the small intestine at its attachment at two different points, one for a distance of three inches and the other for eight inches. After ligating the bleeding vessels (Fig. 1) the mesentery was sutured to the intestine, and the omentum tucked around the long damaged loop and tacked in position. (Fig. 2.) Owing to the general condition of the patient a resection was not done. For several days following the operation the patient remained in a serious condition but gradually improved. There was slight drainage from the wound for about ten days. Aside from this the man made an uneventful recovery and left the hospital in about three weeks, and is now in good health, seven years after operation.

CASE III.—Woman, age thirty-eight, had tumor mass completely filling the pelvis, which could be palpated above pubes. This was at first thought to be an ovarian cyst. At operation it proved to be a large mesenteric blood cyst. It was attached close to the intestine and in its removal the blood supply to the intestinal loop was apparently sacrificed for three and one-half inches. The omentum was tacked around the loop and over the raw mesentery. Patient made a good recovery, and is now in good health three and one-half years after operation.

Dog No. 1.—Was operated on March 2, 1923. Six inches of mesentery was ligated and cut away from the intestine, severing all blood supply. (Fig. 1.) The mesentery was then sutured to the intestine to close the opening and omentum was tacked around the damaged loop. (Fig. 2.) The dog made a good recovery. Three months later the dog was again operated on to explore the result. It was found that omentum was densely adherent to the intestinal loop and exceedingly vascular.

Dog No. 2.—Was operated on March 5, 1923. Eight inches of mesentery was ligated and separated and treated as in dog No. 1. This dog made a good recovery and got away two weeks after operation.

Dog No. 3.—Was operated on March 12, 1923. I meant to separate the mesentery for about ten inches, but when the vessels were tied and the mesentery severed I found that thirteen inches had been separated. This dog at first vomited more than the others but apparently made a good recovery, and was able to take all kinds of food. Five weeks after the operation the dog was found dead in the morning without any signs of having been sick the day previous, having taken food well, and was as playful as usual. Unfortunately, I was out of town attending the state meeting and did not get to autopsy this dog. After five weeks of normal health it does not seem plausible to assume that this dog died from a failure of this intestinal loop to regain its vitality. This dog was pregnant at the time of operation which might have been a factor. All these dogs were fed all kinds of food, including bones.

## COMMENT

At this stage of the clinical and experimental work I am unable to say where these long loops of intestine, freed from their mesenteric blood supply, got sufficient nourishment to survive. The mesenteric vessels near the intestine are said to be terminal and do not anastomose in the intestinal coats. It does not seem plausible that simple suturing of detached mesentery with its ligated vessels back to the intestine would establish blood supply sufficiently early to save the damaged loop. Therefore it would appear that wrapping the omentum around the intestine and suturing it in position (Fig. 1) hastens the formation of plastic adhesions about the loop, thus facilitating the reestablishment of the blood supply. On exploring one of the dogs two months after operation the omentum, mesentery, and the intestine itself were found to be

very vascular at this area. Aside from the scientific and clinical interest, the important practical point is that a long loop so treated does survive, making a resection unnecessary. I am not prepared to say that it would always be safe to ignore a loop of intestine separated from its mesentery from eight to ten inches as the clinical and experimental work might tend to show. However, in border-line cases already severely shocked, I am of the opinion that it would be safer not to do a resection, certainly, where no more than four or five inches are separated, which is about twice the previously recognized border line. More conservative surgical treatment promises the better result.

If one would look over records of resections in different hospitals and work done by different operators it would be found that the results would be far from satisfactory. I am unable to say whether this is due to a faulty technic or to the pathology dealt with. Probably both are factors, but I should say the traumatic or pathologic condition for which a resection is usually done is often a very grave condition itself, and when the shock of a resection is superimposed the mortality will be much higher.

I recall that early in the war the mortality from intra-abdominal injuries was so high in the British Military Hospitals that a commission was sent out to investigate it. It was decided that too many resections were being done, and they sent out a bulletin urging that resections be avoided wherever possible and that simple closures of intestinal injuries be done instead, even though it caused considerable narrowing and angulation of the intestine. Following this the results were better and the mortality reduced. Therefore it is desirable, in dealing with mesenteric and intestinal injuries, to resect only in the presence of urgent indications.

## CONCLUSIONS

1. This limited clinical and experimental work would tend to show that a much more extensive sacrifice of the blood supply to an intestinal loop can be tolerated than has heretofore been taught and practiced.

2. It necessarily follows that the number of intestinal resections can be materially reduced with a reduction of mortality, shortening of convalescence and increase in number of complete recoveries.

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# THE INTERPRETATION OF CHOLECYSTOGRAPHIC FINDINGS*

## OPERATIVE CHECK IN TWO HUNDRED AND SEVENTY-SEVEN CASES

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As SURGEON in an institution dealing with a large number of patients suffering from gall-bladder disease, it has been the privilege of the essayist to devote considerable time in the last three and a half years to the development of cholecystography. It is the purpose of this paper to summarize the practical results of this test in a series of more than 2,000 patients suspected of gall-bladder disease, and the operative check on nearly 300 of these patients from our surgical service. In practically all of the borderline cases, Dr. A. S. Warthin's opinion was obtained on the pathological findings, and even in some of the cases showing gross disease the specimen was referred to him for study.

Cholecystography has achieved such popularity and wide use in connection with gall-bladder surgery, it is unnecessary to devote much space to the brief but eventful history of this valuable test. We should not fail to express our debt of gratitude to Graham, Cole, Copher and Sherwood Moore for their devotion to the problem of visualizing the gall-bladder.

Röntgenologic interest in the gall-bladder began with the work of Carl Beck, of New York, who in 1900[1] reported several cases of gall-stones discovered with the X-rays, including one notable instance of gall-stones on the left side in a case of *situs inversus,* all confirmed by operation. No studied effort was made to discover gall-stones röntgenologically in a routine manner until our first published paper on this subject in 1913[2] and the paper by L. G. Cole,[3] prepared simultaneously but published a few months later. Pfahler[4] and Haenisch[5] at the 1910 meeting of the American Röntgen-Ray Society reported several cases, and at that same meeting we displayed in the scientific exhibit seven röntgenograms of gall-stones *in vivo,* several of them stereoscopic. A. Beclere,[6] of Paris, in 1910, discussed the radiologic differentiation between urinary and biliary calculi, and H. Beclere,[7] of Paris, the following year, published a monograph on radiology of the liver with special reference to hepatic abscess. Since then numerous publications on gall-bladder röntgenology have appeared—too numerous to mention. Reference should be made to Knox,[8] Thurstan-Holland,[9] George and Gerber,[10] Caldwell,[11] Kirklin[12] and Carman[13] for special prominence in contributions to the subject.

However, in spite of painstaking analysis of methods and correlations of mechanical and clinical findings, it was evident that röntgenology could not furnish reliable help in more than 30 to 40 per cent. of cases; and the dis-

tressing lack of help was most apparent in the very cases where it was most needed. Up to the time of Graham's first announcement (February, 1924) the only really reliable direct evidence of gall-bladder disease was the demonstration of stones containing enough lime to cast a röntgen shadow.

As indirect evidence, a number of signs had been advanced, including (a) an inconstant deformity of the duodenal bulb, (b) a gall-bladder impression in the duodenum, (c) evidence of adhesions involving the duodenum beyond the duodenal bulb (duodenitis), (d) spasmodic manifestations in the stomach, (e) hepatofixation of the stomach, and (f) visualization of the gall-bladder itself.

Some of these signs have proven to be of considerable worth, especially "hepatofixation of the stomach", "midgastric spasm", and "adhesions about the duodenum beyond the bulb", although the duodenal adhesions beyond the bulb are in our opinion more suggestive of periduodenitis than of a gall-bladder lesion.

The "gall-bladder impression" has been seriously objected to as a sign of gall-bladder disease for the simple reason that in the light of our present knowledge, based on the Graham test, we recognize that the gall-bladder is by no means usually responsible for this impression; and even if it were, there is no proof that the gall-bladder needs to be pathological to cause such an impression. There are often present lobes of the liver about the size and shape of the gall-bladder, which could easily make this impression. Furthermore, in many of these cases where the so-called gall-bladder impression was present, we found by cholecystography that the gall-bladder was located elsewhere and did not coincide with the seat of the crescentic duodenal deformity.

The "inconstant deformity of the duodenal bulb" may be due to a great many things. It is true the deformed duodenal bulb is sometimes found in gall-bladder disease, but it is also found in connection with a number of other lesions, c.g., highly nervous states, spastic stage of tabes, hyperthyroidism, appendicitis and in periduodenitis.

The "visualized gall-bladder" (without the introduction of dye) has been impeached as a sign of gall-bladder disease for at least two very important reasons: Even though the gall-bladder shadow is visualized, we have no reason to believe that this visualization indicates the presence of disease. Furthermore, there is grave reason to doubt the gall-bladder identity of the shadow which has been supposed to represent the visualized gall-bladder. It was supposed that any ovoid shadow in the right upper quadrant corresponding approximately in shape and size to the gall-bladder was the gall-bladder, especially if in addition to this shadow one could definitely identify the inferior border of the liver and the outline of the right kidney. In some instances, indeed, reports went out basing a diagnosis of cholelithiasis (cholesterin stone) upon a filling defect occupying roughly the centre of this ovoid shadow. We now know that in a great many instances this ovoid shadow mistaken for the visualized gall-bladder was in reality caused by the

duodenum in some instances, and the pyloric end of the stomach in others, or by a combination of the two. The filling defect in the shadow was nothing but a bolus of air imprisoned in the duodenum. This is easily demonstrated in Figure 1, which shows such a rounded area of density containing air, which undoubtedly represents a cross-section of the duodenal bulb,
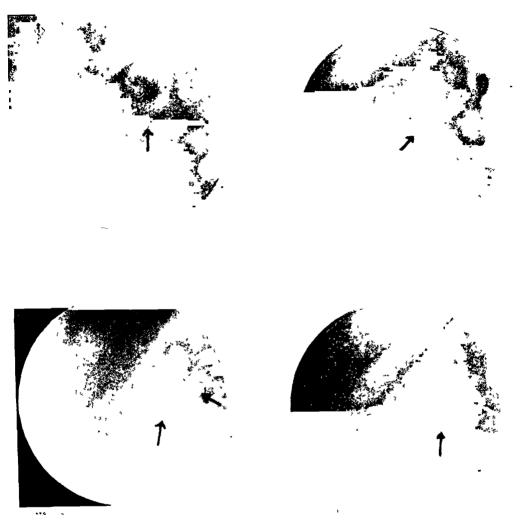


FIG. 1.—Four illustrations from the same case showing in the two upper circles, marked by arrows, the rounded shadow of the duodenum seen in profile, containing gas; in the lower two circles the same rounded shadow seen in relation to the gall-bladder visualized by cholecystography.

with air arrested therein. Figure 2 is an anatomical drawing illustrating the posterior direction taken by the duodenal bulb and the upper part of the second portion of the duodenum. It makes plain that the shadow of the duodenal wall is for a considerable distance seen in profile, thus giving most favorable conditions for casting an ovoid shadow, ofttimes imprisoning a small quantity of gas. Cholecystography permits us to demonstrate that this visualized shadow is not due to the gall-bladder, for in hundreds of cases after the introduction of the dye the gall-bladder is seen lying to the outer side of this suspected ovoid density. Indeed, we sometimes see a deformity of the gall-

bladder evidently due to the duodenum; so that it is just as proper to speak of a duodenal impression on the gall-bladder as of a gall-bladder impression on the duodenum.

Thanks to the Graham test, we are now able to very greatly expand the usefulness of the röntgen examination in gall-bladder disease.

*Author's Technic.*—We prefer the intravenous method, although occasionally the dye is given by mouth. The intravenous injection of the dye is made in the late afternoon (4:00 to 5:30) and the first röntgenograms are made at 8:00 A.M. the following day. The first films having been approved, the patient then eats a breakfast containing as much fat as possible and at 12:00 NOON returns to the X-ray department for further röntgenograms. In special cases, the study is pursued for a longer time.

Our early experiences with tetrabromophenolphthalein were somewhat unsatisfactory, owing to the vascular depression following the injection of this bromine compound, which was sometimes so marked as to cause the patient and his friends a great deal of alarm. In our experience with approximately one hundred injections of the bromine salt we had no case which gave us any alarm, although sometimes there was a very disconcerting temporary drop in the blood pressure. With the iodine compound, however, our injections
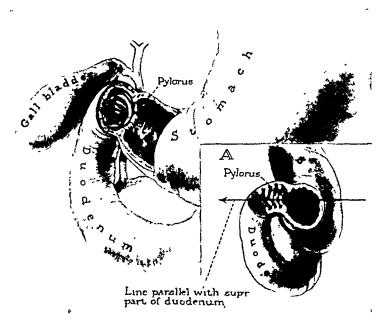


FIG. 2.—An anatomical drawing illustrating the posterior direction taken by the duodenal bulb and the upper part of the second portion of the duodenum. Note how the shadow of the duodenal wall is for a considerable distance seen in profile, thus giving most favorable conditions for casting an ovoid shadow, ofttimes imprisoning a small quantity of gas.

have not been followed in any case by serious blood-pressure drop and the percentage of reactions following the injection has been very small. In the tetrabromophenolphthalein cases we were able to avoid the vascular depression by the concomitant use of adrenalin. With tetraiodophenolphthalein, less than 10 per cent. of our patients suffer any unpleasant reactions which they mention the next morning.

The patient appears at the office at four or five in the afternoon and lies down on a couch or table with the left arm extended upon an arm board; the bend of the elbow is sterilized with one-third-strength tincture of iodine in alcohol. Sterilized towels are placed about the arm and a tourniquet of rubber tubing put on the arm with forceps, just tight enough to distend the veins but not to cut off the pulse. The patient clenches his fist, thus tensing the muscles of the forearm and distending the veins. A hypodermic needle, 18-gauge, attached to a glass hypodermic syringe, is thrust into one of the prominent veins in the bend of the elbow, and just sufficient blood withdrawn to make sure that the needle is securely within the lumen of the vessel. The hypodermic syringe is then twisted loose from the needle and the end of a rubber tube, previously made ready and attached to a burette filled with warm Ringer's solution, is attached to the needle, and the tourniquet released, thus starting at once the flow of warm Ringer's solution into the vein. We use an ordinary burette of 150 to 200 c.c. capacity such as was formerly employed for salvarsan work. As soon as the flow of Ringer's solution is estab-

lished, the nurse pours into the burette the solution of tetraiodophenolphthalein already prepared * and this, diluted by the addition of 75 to 100 c.c. of warm Ringer's solution, is allowed to flow into the vein. The injection proceeds as rapidly as the gravity method permits, four · or five minutes being sufficient for the injection. The dye is followed up at once by 15 or 20 c.c. of clear Ringer's solution to wash out the needle and the vein, after which the needle is withdrawn. The patient is then caused to lie down for fifteen minutes. The evening meal may be taken, but the patient is asked to confine the diet to carbohydrates (fruits, fruit juices, sugar, rice, potatoes, lemonade) excluding fats and proteins. The patient is usually requested to go home and go to bed for the evening. If the patient has been on a milk diet, the test is likely to be inaccurate.

At eight o'clock the next morning, before breakfast, fourteen or fifteen hours after the injection, the patient appears at the röntgen department, at which time two 20 by 24 centimetre films of the gall-bladder region are exposed. These are developed at once to make sure that they are technically satisfactory. The patient is then allowed to go to his breakfast, eating whatever is pleasing but including in the breakfast milk or cream and an egg yolk. It is our custom to let the patient return at twelve o'clock for two more films. We thus have four films, two made at the fourteenth hour before breakfast and two at the eighteenth hour, approximately three and a half hours after a breakfast containing fats. By the foregoing technic the patient is permitted to follow his usual program in the day, any discomfort or disagreeable symptoms having occurred the evening before.

In favor of the late afternoon injection is the observation familiar to every surgeon that a gall-bladder fistula flows much more freely at night than in the daytime. Indeed for this reason some surgeons recommend that all their cholecystomized patients be given regular feedings during the night in order to maintain a maximum flow of bile into the intestines and to minimize the discharge of bile through the fistula.

Excellent clinical results following employment of the oral method have been reported by numerous authors, including Menees,[14] who first suggested the oral administration, Stewart,[15] Carman,[16] and others; but we have preferred the intravenous method for various reasons, some of which appear later.

There are reactions which follow both the oral and the intravenous administration of the dye. Digestive upsets, such as headache, vomiting, nausea and purging occasionally follow the oral administration; similar reactions are noted following the intravenous administration except that diarrhœa is a very rare complaint. It is interesting to note that patients who develop urticaria following intravenous cholecystography complain of being subject to urticaria; those who have headaches usually have put down headaches as one of their subjective complaints for the relief of which they came to the institution; those who suffer an asthmatic attack are subject to asthma.

In over two thousand intravenous administrations we have had only one reaction which gave us alarm, that of an elderly physician who became unconscious fifteen minutes after the injection of the dye, but who the next morning felt perfectly all right. Advanced cardio-renal disease is

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* Three and one-half grams of Mallinckrodt's tetraiodophenolphthalein are dissolved in 25 or 30 c.c. of properly sterilized Ringer's solution, and boiled in a water bath for fifteen minutes.

probably a definite contraindication to the intravenous Graham test. There have been a few instances of phlebitis, not over 1 per cent. of the cases, and in only one instance was the trouble in the arm of serious consequence. This occurred in a patient with cardiorenal disease who had suffered amputation of both breasts. Entry into a vein was secured only with difficulty and in spite of carefully washing the vein with Ringer's solution after the dye had been introduced, a phlebitis developed which gave trouble for some months. We have not observed any abscess formation in the arm. When difficulty is encountered in finding a suitable vein in the bend of the elbow, we have occasionally utilized a vein on the dorsum of the hand.

Ordinarily the only reaction experienced by patients following the intravenous method is a vaso-dilatation, notably a flushing of the face, appearing while the injection is still proceeding, which is followed almost immediately by a pallor of short duration. The patient mentions that he can feel his heart pounding. We keep our subjects recumbent for fifteen minutes following the injection, after which time they are allowed to go on about their business. Very rarely does the patient the next morning recall any inconveniences which he cares to mention. Certain races especially susceptible to emotional influences seem to be predisposed to a reaction. The writer recalls particularly one patient who exclaimed, "There, I knew I would have a reaction," before we had even introduced the needle. Another patient fainted after the needle had been introduced but before any Ringer's solution or dye had had time to enter the vein.

Let me state once more that the average patient complains of no discomfort whatever and those who do complain usually suffer nothing more than a species of malaise which is gone within an hour. We rarely find it necessary to use adrenalin. Those who suffer discomfort are told to take some hot water with bicarbonate of soda. I, myself, after taking the injection, immediately got up from the table and proceeded with the remaining two hours of my afternoon's work, attended a medical society meeting that night and did my usual list of operations the next morning without any discomfort whatever. Two of my assistants had a similar experience.

The intravenous method has the very great advantage over the oral in that a definite dose of the dye has been positively introduced into the blood stream, there being no question of failure of capsules to dissolve, incomplete absorption of dye, etc.; under these conditions failure to obtain a gall-bladder shadow and a faint shadow density are therefore very significant and to be definitely interpreted. In looking over the summaries of cases of several authors who have used the oral method, it is evident that in a considerable proportion of their Graham tests there is no basis afforded for an interpretation. For instance, in a series of one hundred cases reported by one author, in twenty-eight there was no gall-bladder shadow, in thirteen the examination was unsatisfactory and in eleven the capsules failed to dissolve, making at the lowest count 28 per cent., and at the highest 52 per cent., of the cases in which he had no right to express any opinion at all; whereas with the

intravenous method one is justified in giving an opinion in practically 100 per cent. of the cases.

A word further with reference to reactions: In the year 1926, 831 Graham tests were given in our service by the intravenous method. No reactions at all were reported in 577 cases. Reactions varying from vomiting to a slight feeling of weakness were reported by 254 cases. In these 254 cases vomiting was reported in twenty-eight; shortness of breath and a tightness of the chest in thirteen; urticaria in ten; diarrhœa in nine; and a sore arm in two cases. Of the urticaria cases three were subject to urticaria. In the cases reporting shortness of breath several were subject to asthmatic attacks. We thus had sixty-two cases out of 831, or 7.5 per cent., reporting disturbing reactions, surely not a great figure compared with the frequent digestive reactions following the oral administration of the dye.

In reporting on cholecystographic examinations we have devised the following terminology:

*Stone Positive.*—If gall-stones contain enough lime to cast positive shadows, the Graham test is quite unnecessary except as a means of identifying certain densities which may not clearly represent gall-stones. One has to exclude renal stone, calcified mesenteric glands and islands of calcium deposit in the right lower rib margin. Stones containing no lime or too little lime to cast positive shadows are recognized with the Graham test as negative areas in the gall-bladder shadow. Gas in the colon and especially gas in the duodenum may cause considerable confusion in the interpretation of negative areas lying within the gall-bladder outline. It is especially important in such cases to repeat the X-ray films after the patient has been given cleansing enemas. In making these renewed studies the tube should be tilted in such a manner as to throw the gall-bladder shadow into a different relation to the shadow of the colon or spine. A faint gall-bladder shadow overlying the spine might be easily overlooked. Gas retained in the duodenal bulb may on account of the natural contours of the collapsed duodenum greatly resemble the faceted appearance of negative stone shadows. Sacculations of the gall-bladder caused by pericholecystic bands, especially when these adhesions occur about the gall-bladder neck, may cause error by retaining small "puddles" of dye after the gall-bladder has been otherwise emptied. A papilloma or other tumor on the skin lying next to the film may cast a shadow sufficiently dense to cause confusion. Tyson[17] has reported a case of metastatic hypernephroma within the gall-bladder which quite likely would have led to a diagnosis of gall-stone if the case had been submitted to cholecystography.

Up to this date (November 15, 1927) there have come to operation in the writer's surgical service seventy-seven patients in whom a pre-operative Graham test report of "stone positive" had been made. There were three errors, one due to sacculation of the gall-bladder; the other two due to calcareous deposits in the gall-bladder wall. In the case due to sacculation there were pericholecystic bands practically dividing the gall-bladder into

three sacs, and as the gall-bladder emptied two of these sacculations retained a sufficient amount of dye to make us suspect the presence of gall-stones. This was one of our early cases, encountered while we were still harboring the idea that gall-stones sometimes imbibe such an amount of the opaque matter that previously non-opaque stones might become somewhat opaque. We now know that this is not the case. Experiments made by soaking gall-stones for many hours in a solution of tetraiodophenolphthalein have shown that the gall-stones do not imbibe any of the dye. The following table sets forth our results in this series.

TABLE I "STONE POSITIVE".

Total cases operated ...................................... 77
Stones found at operation................................ 74
Errors .................................................. 3
      Error 3.9 per cent.        Reliability 96.1 per cent.
Errors in first series of 46 cases......................... 3
Errors, second series of 31 cases........................ 0

*Absence of Shadow.*—Failure to discover a gall-bladder shadow following the administration of the Graham test, especially when the dye has been given intravenously, constitutes the most convincing reliable and important evidence of disease of the biliary tract. Normally the dye-containing bile passes freely from the common duct into the gall-bladder, where. it attains a concentration so pronounced that the gall-bladder shadow clearly shows in the röntgenogram. This concentration of the gall-bladder bile has been variously estimated as being four to ten times more dense than the common duct bile. When, after careful study, we fail to perceive the gall-bladder shadow, we are then convinced that one or more of a number of causes have been operative to prevent visualization of the gall-bladder. The following may be mentioned as the most important causes, an effort being made to list them in the order of their probability:

1. Cystic duct obstruction. This may be due to a stone impacted in the cystic duct or in the neck of the gall-bladder; or, less frequently, kinking or other form of obstruction of the common duct due to adhesions, infiltration of malignant disease in the neighborhood, or pressure of an extra-biliary tumor.

2. The gall-bladder may be filled with stones and the gall-bladder mucosa damaged to such an extent that the concentrating function is interfered with.

3. Failure of the concentrating function in a stone free gall-bladder, the failure being due to disease of the gall-bladder wall, interfering with the glandular activity.

4. Stones or other obstruction of the common duct. Because the gall-bladder is not able to empty itself, there does not occur the normal interchange between the dye-containing bile and the bile which is free from dye. The result is an absence of gall-bladder shadow.

5. Organic disease of the pancreas or liver or both, such as carcinoma. hepatic cysts or abscesses, or advanced hepatitis.

6. Failure of patient to follow instructions not to eat fat until a certain period has elapsed after the injection. It is possible to completely nullify the value of the Graham test by either the oral or the intravenous method if the patient does not adhere strictly to instructions regarding a carbohydrate evening meal. We were surprised to find one of our young patients with relatively slight clinical indications of gall-bladder disease showing an absence of gall-bladder shadow. Careful inquiry into the case elicited the confession that he had eaten three bromose tablets four hours after the injection. We therefore repeated his Graham test, thinking that these tablets, which are rich in vegetable oils, might have caused evacuation of the gall-bladder, and found a normal response to the test. We therefore repeated the test experimentally on several normal subjects and found in all of them that the taking of two or more bromose tablets four hours after the injection of the dye prevented visualization of the gall-bladder. We have also found it difficult to visualize the gall-bladder of patients on a milk diet. Therefore in all cases in which we have a report "absence of shadow" we carefully interrogate the patient with reference to dietetic faults contrary to instructions, believing that these dietetic faults explain the few errors which we have encountered in checking up our results on "absence of shadow" reports.

TABLE II. "ABSENCE OF SHADOW".

Total number of cases operated.......................... 79
Stones found present (73.4 per cent.).................... 58
No stones found (26.6 per cent.).......................... 21
Errors (normal at operation) (2.5 per cent.)............. 2
Reliability in finding gross disease of biliary tract (97.5
     per cent.)

An analysis of the twenty-one noncalculous cases where "absence of shadow" was reported is given in the following table:

TABLE III. "ABSENCE OF SHADOW".

Total cases checked at operation.......................... 79
Gall-stones present ...................................... 58
No stones found in........................................ 21
In these twenty-one cases, the diagnosis was as follows:
     Carcinoma of pancreas or common duct.............. 5
     Abscess of liver .................................. 1
     Cirrhosis of liver................................. 2
     Chronic pericholecystitis, adhesions especially about
          gall-bladder neck ............................. 5
     Papillomatous gall-bladder ........................ 1
     Chronic cholecystitis, fibrosis of walls, thick, black, tarry
          bile ............................................ 5
     Cause of absence of shadow not apparent, normal bile
          being found in gall-bladder..................... 2
                                                         ——
                                                         21

230

The two failures to visualize the gall-bladder referred to in the last line of the above table were evidently cases of error. Interrogation of the patients led us to believe that the error was due to failure to follow out dietetic instructions.

"Absence of shadow", therefore, signifies gross disease of the biliary tract with only 2.5 per cent. probability of error. In 73.4 per cent. of cases stones were found at operation; in 87.3 per cent. of cases gross disease, either stones or other pathology, in the gall-bladder itself; in 10.1 per cent. gross disease of the biliary system outside of the gall-bladder.

Cases of jaundice almost invariably give "absence of shadow" and we no longer give the Graham test in cases of definite jaundice.

In seventeen cases where an "absence of shadow" was reported, the test was repeated by the intravenous method. In fifteen it had been given in the first place by vein, in two orally. The "absence of shadow" was confirmed in thirteen cases. The two which had been tested previously by the oral method were found to be normal by the intravenous method. One showed an insufficient density. In the light of our experimental observations, the three cases which were normal on repeat were probably cases of failure to observe dietetic restrictions after the first test.

*Normal.*—Normal Graham tests were reported when the gall-bladder outline appeared at the fourteenth hour with normal contours, normal uniform density and normal emptying; that is, having nearly, if not completely, evacuated the dye within three hours following the ingestion of a breakfast containing fat (breakfast of patient's choice, including, however, the yolk of two eggs or a glass of half milk and half cream, preferably both).

In checking the results of cases reported "normal" which have come to operation, we have been guided by the following surgical criteria: (1) Presence of gall-stones. (2) Presence of pericholecystitis. (3) Enlargement of the sentinel gland of Lund. (4) Opacity or thickening of gall-bladder walls. (5) Hepatitis, especially localized in the gall-bladder region.

Up to November 15, 1927, there had come to operation in our surgical service at the Battle Creek Sanitarium thirty-six cases in which a pre-operative Graham test report had been given as "normal".

The following table represents our operative findings on these thirty-six cases:

TABLE IV. "NORMAL".

Cases checked at operation, gall-bladders................... 36
    Palpated but not removed........................ 11
    Palpated, inspected, not removed................ 15
                                  26
    Gall-bladder removed ..................... 10
      Of these, Dr. A. S. Warthin reported,
      As normal ...................... 7
      As pathological ..................... 3
  In none of these thirty-six cases was stone found.

The reliability of the "normal" report for the exclusion of stone in the gall-bladder was 100 per cent. There is some discussion forthcoming on its reliability toward excluding noncalculous disease. Some will object that in the gall-bladders not removed there might have been disease demonstrable only on removing the organ and referring it for microscopic study. The ten gall-bladders in this series removed by cholecystectomy were referred to Dr. A. S. Warthin, who reported seven as normal and three as definitely pathological, but in none of them was the pathology of an advanced grade. Therefore, on the basis of the cases actually removed and examined microscopically, the normal report is worth 70 per cent. toward excluding gall-bladder disease; but judging by the commonly accepted surgical criteria of noncalculous disease of the gall-bladder we were able to exclude gall-bladder disease in twenty-six further cases of this series. It is thus evident that for excluding gall-bladder disease, even that shown microscopically, this test was worth 70 per cent. based upon ten cases, but for excluding gross disease of the gall-bladder, based on thirty-six cases, the test was worth 83.4 per cent. After all, at the operating table, the surgeon usually depends upon the macroscopic appearance.

The pathological reports (A. S. Warthin) on the ten cholecystectomies in this series with a pre-operative Graham test of "normal" are listed as follows:

183–947 Normal gall-bladder.
184–976 Normal gall-bladder.
171–259 Normal gall-bladder.
180–042 "Slight catarrhal inflammation. Practically normal. Why did you remove it?"
186–523 "Very slight catarrhal cholecystitis. Practically normal."
189–424 "Practically normal. Slight catarrhal cholecystitis."
185–511 "Practically normal. Very slight fibrosis."
181–504 Typical strawberry gall-bladder.
198–362 Papillomatous gall-bladder.
170–726 Strawberry gall-bladder.

Very important in this analysis of the cases with "normal" report which came to operation is the fact that no stones were found in any of them. Furthermore, it is evident from the perusal of Doctor Warthin's reports that in only three cases of the ten was the pathology of any consequence, and in these it was of the type called "strawberry" gall-bladder, of the importance of which as a surgical indication a great many internists have not yet been convinced.

*Pathological Noncalculous.*—This classification includes those cases where no stones are recognized but the gall-bladder shadow is imperfect as to one or more of the following items: Form, density or evacuation. Irregularities of form may be due to pressure from without, as, for instance, the duodenal impression above mentioned, the pressure of an enlarged liver, or of a tumor of the head of the pancreas, or of enlarged glands. An abnormality of form may also follow operation. It may be taken as a fact that

after cholecystostomy adhesions of the gall-bladder are a constant finding. When the density of the gall-bladder is faint, provided the test is given by the intravenous method, we may conclude that the concentrating function of the gall-bladder is imperfect. Our experience shows that these cases are usually to be classified as chronic catarrhal cholecystitis, usually of the so-called strawberry type. When the gall-bladder shadow is very faint, it is manifestly impossible to estimate the emptying time, but occasionally we find gall-bladder shadows of normal density which become even more dense at the eighteenth hour and do not disappear for three or four days. These are manifestly cases of abnormal emptying and the significance may be important. The following tabulation shows our findings in eighty-five such cases checked at operation.

TABLE V. "PATHOLOGICAL, NONCALCULOUS".

Total number of cases checked at operation............. 85
Found pathological gall-bladder in...................... 71
Normal gall-bladder on palpation and inspection.......... 14
Value of test in finding diseased gall-bladder............ 83.6 per cent.
Number of cases in this series, stones found at operation.. 6
Value of report toward exclusion of gall-stones............ 93 per cent.

Again, we may be criticized for leaving fourteen of these gall-bladders in place, since our judgment is based upon macroscopic rather than microscopic findings; but if so, the error here will be offset by the error in the normal group. The surgeon at operation must depend upon palpation and inspection plus the history to guide him in deciding whether or not to remove the gall-bladder. Our practice is to do cholecystectomy or else leave the gall-bladder alone, except in those relatively infrequent cases where cholecystostomy is a life-saving procedure.

It will be noted that in the above table there were six cases showing stone at operation. In all these cases the stones were small, in several of them one single small stone, the size of a rice kernel. If we had not tried to exclude cholelithiasis in this group, our accuracy would have been greater than the 83.6 per cent. reported.

*Value of the Graham Test in Cholelithiasis.*—We have in this series of 277 cases a total of 121 reported "noncalculous". Table VI sets forth the reports following Graham's test on these 121 cases.

TABLE VI. VALUE OF GRAHAM TEST TOWARD EXCLUDING CHOLELITHIASIS.

Total cases reported "noncalculous".................... 121
Of these, the Graham test report was
    "Normal" in  .................................... 36
    "Pathology, noncalculous" in.................... 85
At operation, stones were found in................... 6
Error 4.8 per cent.                Reliability 95.2 per cent.

In other words, the "normal" or "pathological, noncalculous" report, as described in this paper, almost certainly excludes stone in the gall-bladder, the error being less than 5 per cent. It is of special interest to note that no

stones were found in any of the thirty-six cases reported "normal". Unless the test is given by the intravenous method, the second and largest group of this series, the "pathological, noncalculous", could not be included; for by the oral method variations in density of the gall-bladder shadow would be worth too little to mention.

Toward the confirmation of a diagnosis of cholelithiasis, we also have some valuable data, based upon 138 cases of this series where the operated gall-bladder contained gall-stones as shown in Table VII.

TABLE VII. VALUE OF GRAHAM TEST TOWARD THE DIAGNOSIS OF CHOLELITHIASIS.

Total number of operated cases with stones.............. 138
Of these cases, the Graham test report was
    "Absence of shadow" in........................ 58
    "Stone positive" in.............................. 74
    "Pathological, noncalculous" in................... 6
    "Normal" in .................................... 0
Error 4.3 per cent.          Reliability 95.7 per cent.

This tabulation shows that with an error of less than 5 per cent. we were able to report either a "stone positive" or "absence of shadow" (in 75 per cent. of "absence of shadow" cases, gall-stones are present) in 132 out of 138 cases.

*The Present Value of the X-ray in the Diagnosis of Gall-stones.*—The Graham test when positive for stone is worth 96 per cent.; when negative for stone, it is worth 95 per cent. Our experience shows that in 95 per cent. of the cases of cholelithiasis, one at least of the following positive X-ray signs should be present:

1. Stones visible by direct X-ray examination without resorting to the Graham test (such stones contain lime sufficient to make positive shadows).

2. Stones visible by negative areas in the cholecystographic shadow.

3. Failure of the gall-bladder to visualize after the Graham test by the intravenous method.

SUMMARY

Summarizing the entire 277 cases which represented our personal operative experience on Graham tested patients up to November 15, 1927, we have the following table with an average of correct reports in 90 per cent. of the cases.

TABLE VIII. GENERAL VALUE OF GRAHAM TEST—OPERATIVE CHECK.
November 15, 1927.

| Graham Test Report | Cases | Error | Correct |
|---|---|---|---|
| "Stone positive" ............ | 77 | 3. | 96.1 per cent. |
| "Absence of shadow" ........ | 79 | 2 | 97.5 per cent. |
| "Pathological, noncalculous".. | 85 | 14 | 83.6 per cent. |
| "Normal" .................. | 36 | 7 | 83.4 per cent. |
| Total .................. | 277 | 26 | 90 per cent. |

Not for one moment would we suggest dependence upon the Graham test to the exclusion of other findings. We feel that a carefully taken history is of the greatest value in these cases, and careful attention should be given to the physical findings and other laboratory reports. It is evident that the Graham test affords us very great help, so great indeed that no surgeon should attempt to do without its aid.

The test also has a useful place in differentiating right upper quadrant shadows. We sometimes find in the right upper quadrant localized densities, evidently due to lime deposits, which lack the characteristic appearance of gall-stones. Graham's test will often be quite sufficient to identify these shadows without the necessity of subjecting the patient to the more distressing pyelography. We recall several cases in which combined pyelography and cholecystography was done, proving that certain shadows were located neither in the kidney nor in the gall-bladder.

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# RELIEF OF OBSTRUCTIVE JAUNDICE FROM TUMORS IN THE HEAD OF THE PANCREAS *

By Waltman Walters, M.D.

AND

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FROM THE MAYO CLINIC

Moynihan's analysis of the indications for operation in cases of obstructive jaundice states the case clearly: "No one living is infallible in the differential diagnosis of obstructive jaundice. The diagnosis is always so difficult and the chance of a life saved so important, that however positive the evidence of malignancy may be I now advise operations in all cases. It is impossible for the most astute clinician or the most subtle pathologist to discover from the anamnesis or from the chemical examination of urine and feces whether a simple or a cancerous disease of the biliary passages and pancreas is present. He may shrewdly guess but a guess is a poor peg on which to hang a man's life. The mortality of cholecystenterostomy now is trifling if we take into account the severity of the disease and the outlook if nothing surgical is attempted. Apart altogether from the prolongation or saving of life, almost every patient will declare that the relief from the maddening torture of itching is worth every sacrifice. I suspect that the mortality from suicide in this disease is greater than that from the operations which afford relief."

To this may be added that the sagacious surgeon will frequently forego the temptation to make a definite diagnosis of the underlying lesion in the head of the pancreas even when through the opened abdominal wall he can see and feel the involved tissues. He will, however, be able to make an anatomic diagnosis and plan the procedure necessary for mechanical relief.

It is inadvisable to cut out a piece of pancreatic tissue for microscopic examination, since this will prolong the operation, invite oozing in the patient predisposed to bleeding by reason of jaundice, and introduce the avoidable risk of a pancreatic fistula.

The diagnostic criteria necessary to the classification of cases of jaundice as surgical or non-surgical are relatively simple, consisting essentially of pain, the behavior of the serum pigment curve and a determination of whether or not bile is reaching the intestine. It may be taken as a rule that jaundice associated with severe pain should be considered surgical unless malignant metastasis can be demonstrated, or a primary malignant growth of the gastro-intestinal tract from which obstructing metastatic growths may have

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arisen. If the onset and the course of the jaundice have been painless, if repeated duodenal siphonage fails to recover bile and if the serum bilirubin curve remains stationary or rises, it may be assumed that an obstructing malignant tumor of the head of the pancreas is present. If the jaundice has commenced without colic, if there is a free flow of bile into the intestine and if the serum pigment curve falls steadily, intrahepatic and therefore non-surgical disharmony is probable. This group of cases should be kept in mind since, while the patients may conceivably recover after an operation such as internal drainage, the recovery is in spite of the surgical procedure, not because of it, and might well be prejudiced by the influence of the anæsthetic or the risk of hæmorrhage. That diagnostic rules in jaundice are fallible is well illustrated by the cases reported here. It will be observed · that in only one case, Case VII, was a diagnosis of malignancy proved. It is assumed or at least hoped that the remaining cases are benign tumors, either inflammatory or neoplastic. Statistics show that benign lesions of the pancreas which produce obstruction of the bile passages are rare. These cases are, therefore, exceptional not only in the matter of diagnostic difficulty, but because of the gratifying results attained by the surgical procedure instituted.

The benefits to the patient of the relief of jaundice caused from an obstructing lesion in the head of the pancreas by anastomosis between the distended biliary tract (usually the gall-bladder and occasionally the common bile-duct) and the stomach or intestine, reëstablishing gastro-intestinal biliary continuity, is illustrated by the condition of patients whose cases are reported herewith, particularly by the condition of the patient in Case I in which more than two years have elapsed since operation.

Before the inauguration of present methods of pre-operative preparation, before the use of intravenous injections of calcium chloride [4,5] and blood transfusion to prevent bleeding, before the development of a method of measuring the amount of bile pigment in the blood and its fluctuation (van den Bergh), and before the development of tests of renal function, the risk of cholecystenterostomy on deeply jaundiced patients was an exceedingly grave one. Kehr [1] stated that in some clinics it varied between 65 and 75 per cent.

Following the application of the principles of preparation previously listed [4,5] which have been rather generally adopted, the risk of operation on all types of patients with obstructive jaundice has been brought within reasonable limits, and in this clinic is well under 10 per cent.

In a recent paper Wangensteen reported a case of cholangitis following cholecystenterostomy and contrasted the results of anastomosis between the gall-bladder and intestine in experimental animals by Gatewood and Poppins, and others, in which, subsequently, cholangitis invariably occurs with the clinical results of Kehr, Mayo-Robson and Babcock in which cholangitis scarcely ever occurs. After a study of the literature Wangensteen stated that the complication of cholangitis in patients following cholecystenterostomy

has only infrequently been observed and that narrowing or partial occlusion of the stoma, as occurred in the case he reported is the important factor in determining whether the complication of cholangitis will follow.

In the series of eight cases reported here, one of us (Walters) performed cholecystgastrostomy (Fig. 1) on seven deeply jaundiced patients, and cholecystduodenostomy (Fig. 2) on one patient for relief of jaundice due to obstructive lesions in head of the pancreas. An anastomosis of at least 2.5 cm. in diameter, and sometimes 3.5 cm., was made in every instance of cholecystgastrostomy. In the case in which choledochoduodenostomy was performed the immense dilatation of the common duct made possible an anastomotic opening of almost 2 cm. in diameter (Fig. 2).

Six patients are living, free of jaundice and of itching. Three of these feel well, two of whom have gained twenty pounds each. Another reports his condition improved. One reports that he is continually ailing and unable to work. One of the patients on whom cholecystgastrostomy was performed for carcinoma in the head of the pancreas died on the seventh day from what clinically appeared to be renal and hepatic insufficiency. At necropsy the only cause for death found was slight localized peritonitis. Another patient operated on lived comfortably for twenty months after operation. Necropsy by his home physician revealed biliary cirrhosis and terminal pneumonia. Although the tumor in the head of the pancreas had disappeared, the pancreas showed evidence of chronic inflammation.

REPORT OF CASES

Case I.—A man, aged fifty-two, presented himself January 28, 1924, complaining of having lost appetite and energy and forty pounds in weight during the preceding six months. During the preceding two years he had had recurring jaundice of varying intensity without pain.

*Examination.*—General examination did not reveal gross abnormalities, except jaundice of moderate degree. The urinalysis, blood count and Wassermann reaction were negative. The test-meal and röntgenograms of the stomach showed nothing abnormal. The patient was advised to return home and await developments. He returned nine months later, stating that following his examination in January, the jaundice had disappeared and he had gained in weight and felt well until October when the jaundice reappeared without pain. A mass was felt in the area of the gall-bladder and was believed to be the distended gall-bladder. The blood count showed the number of leucocytes to be 10,800. The urine contained urobilin and urobilinogen. The blood urea was 30 mg. for each 100 c.c. and the coagulation time was five minutes. A diagnosis was made of biliary obstruction, probably at the head of the pancreas, and the patient was advised to go into the hospital for exploration. The patient preferred to delay exploration and said he would return, which he did November 23, 1925. The attack of jaundice in October, 1924, had lasted for six weeks, then subsided and he gained weight up to 210 pounds. During the summer of 1925 he appeared to be well but in September, painless jaundice again occurred with light stools and dark urine. Appetite failed; he lost thirty pounds and itching was very distressing. Blood count showed 13,800 leucocytes, 3,820,000 erythrocytes and hæmoglobin 61 per cent. The coagulation time was eleven minutes. A diagnosis was made of recurring obstructive jaundice, graded 2, with obstruction at the head of the pancreas. A globular mass in the region of the gall-bladder was palpable.

*Operation.*—After six days of preparation during which three intravenous injections

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*Operation.*—After six days of preparation during which three intravenous injections

of calcium chloride were given, the patient was operated on December 1, 1925. A tumor was found at the head of the pancreas. The gall-bladder was distended, its walls thickened, and rather creamy in color. The liver was normal in size, but there was diffuse cirrhosis. There were several enlarged glands along the common bile-duct which was dilated and distended. At the head of the pancreas was a thickened indurated area which had the "feel of malignancy" but which may have been pancreatitis. Cholecystgastrostomy was performed using three rows of chromic catgut anteriorly and posteriorly (Fig. 1). The anastomosis was made about 5 cm. above the pylorus.

Convalescence was without incident. The patient was allowed to leave the hospital, December 13, and was dismissed from the clinic, December 18, at which time the wound was healed, the jaundice had subsided and the patient's general condition was excellent.
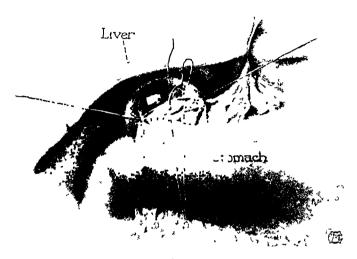


Fig 1 —Cholecystgastrostomy.

March 21, 1927, sixteen months later, the patient returned to the clinic stating that his condition had been excellent for thirteen months. During the last three months, however, he had lost thirteen pounds in spite of the fact that his appetite was good. During this time he had been troubled with gas and diarrhoea and passed frothy stools. General examination did not reveal anything abnormal. There was no jaundice. The hæmoglobin had returned to 70 per cent.; erythrocytes numbered 4,080,000 and the leucocytes 6,500. Urinalysis was negative. The patient was allowed to return home. November 12, 1927, a letter was received from him stating that he was getting along fairly well, feeling about 50 per cent. better than when examined in the clinic in March. He noted improvement each week and was gaining a little weight; his weight at this time was 185 pounds. Appetite was fairly good and the stools were normal. Jaundice had not been present since the operation. The urine was normal. A letter dated February 27, 1928, stated that stools were more natural and that he was having epigastric pains which were relieved by the passage of gas.

*Comment.*—The fact that the jaundice had cleared completely on several occasions over a period of two years prior to operation made us feel that malignancy of the bile passages or pancreas was improbable, especially as the patient had gained weight and had shown general improvement in health during the free intervals. A "silent" or painless common duct stone was a possibility and statistically probable. The last attack was associated with slight rises in temperature. Injury to the liver was anticipated and drainage of the biliary tract seemed clearly indicated, preferably permanent internal drainage.

Although at the time of the operation a differential diagnosis of chronic pancreatitis and carcinoma could not be made, in the light of subsequent events the lesion is judged to be chronic pancreatitis.

Case II.—A man, aged fifty-seven, presented himself August 3, 1927, with a history of stomach trouble for two months and loss of twenty pounds. Distress came on two or

three hours after meals and at 3:00 A.M. and was relieved by eating. Prior to this for a period of thirty years he had had occasional attacks of distress in the epigastric region lasting from one to two hours, and occurring on three or four successive days with intervals of freedom from attacks of several months. This type of distress had been without relation to meals. Two weeks previous to examination jaundice was noticed. The onset was not associated with pain, other than that already described.

*Examination.*—Jaundice, graded 2, was noted in the skin and sclerotics. There was a mass at the level of the umbilicus. Serum bilirubin was 15 mg. for each 100 c.c. of blood. The blood count showed hæmoglobin 61 per cent. and leucocytes 8,800. Bile in the urine was graded 2. Röntgenogram of the stomach showed a deformity of the duodenum suggestive of ulcer. A fractional test-meal showed total acidity 50, free hydrochloric acid 28 and 90 c.c. of fluid in the stomach at the end of one hour. Carcinoma of the pancreas or duodenal ulcer perforating onto the pancreas with obstruction of the common bile-duct was considered pre-operatively. Exploration was advised. The patient was under observation in the hospital for ten days during which time he was prepared for operation in the usual manner. Bile was not obtained by duodenal drainage on four occasions from August 9 to 15. Serum bilirubin on three occasions was as follows: August 20, 20.9; August 22, 16.4; August 31, 18.3. The coagulation time was seven minutes and thirty seconds.

*Operation.*—At operation August 23, 1927, a mass approximately 7 cm. in diameter was found in the head of the pancreas with a crater approximately 1.5 cm. in diameter. To this the duodenum was closely adherent and it is possible that the mass was either a large ulcer on the posterior wall of the duodenum perforating into the pancreas or ulcerating carcinoma of the head of the pancreas. In either event it appeared to be the cause of the biliary obstruction. The gall-bladder was distended and contained about 500 c.c. of thick tarry bile. There were no gall-stones. The gall-bladder was emptied with a trocar and in view of the condition present it seemed advisable to perform a cholecystgastrostomy, which was done using three rows of sutures posteriorly and anteriorly and surrounding the anastomosis with omentum. Two Penrose cigarette drains were used.

The post-operative course was without incident. There was slight gastric retention for the first five days but no fever. The patient was dismissed from the hospital September 10, and from the clinic, September 23, at which time the wound was healed and the general condition good. The day before dismissal the serum bilirubin was 8.3.

A letter from the patient October 10, stated that he stood the trip home well, and that he was feeling quite strong but not gaining weight. His appetite was good and he was eating everything. He had gas pains every day and his bowels were loose, moving several times a day. A letter January 7, 1928, stated that he was getting stronger every day and believed that by spring he would be able to look after the work on the farm. A letter March 1, stated that he had severe epigastric pains. His appetite was good but he had not gained weight. There was not any jaundice or itching.

CASE III.—A woman, aged fifty-one, registered August 4, 1927. She gave a two-year history of attacks of epigastric pain coming at intervals of from two weeks to two months. The pain radiated from the epigastrium to the interscapular region, was not induced or relieved by food and was not eased by soda. The recent colics were severe, being relieved only by the hypodermic injection of opiates. Three months before registration jaundice appeared following colic and had persisted although showing variation in intensity. There had been occasional vomiting, usually after the patient had taken sodium bicarbonate. The loss in weight was twenty-five pounds in four months. The stools and urine had varied in color. There had not been any chills or fever.

*Examination.*—Slight epigastric tenderness was present, the liver was palpable, and the spleen was not felt. Hæmoglobin was 47 per cent.; erythrocytes numbered 3,540,000, leucocytes 7,400. Fluoroscopic examination of the stomach showed nothing abnormal. Siphonage of the duodenal contents on August 9, 1927, did not recover bile. Daily

serum bilirubin estimations from August 8 to 12 showed 6.4, 5.75, 6.2 and 4.1 mg. for each 100 c.c. Our clinical impression was that this patient had gall-stones and that one or more stones had escaped into the common bile-duct.

The patient was sent to the hospital for pre-operative preparation. Intravenous injections of calcium chloride were given.

*Operation.*—At operation, August 13, 1927, a hard, indurated mass was found in the head of the pancreas and throughout the pancreas just below the lesser curvature of the stomach multiple nodules could be felt. There was a suggestion of free fluid in the abdomen. Further evidence of carcinoma was not found. The gall-bladder was moderately distended but was not typical of complete pancreatic obstruction. Stones were not palpated in the gall-bladder or the common bile-duct. Cholecystgastrostomy was performed using three rows of chromic catgut sutures anteriorly and posteriorly and protecting the suture line with omentum. Three Penrose cigarette drains were inserted.

The post-operative convalescence was without incident. Two degrees of fever occurred on the first and second days following operation and from then until dismissal, August 27, the patient ran a normal course with a normal pulse rate throughout. She was dismissed from the clinic, September 2, at which time the wound was healed and her general condition was good. Three days before dismissal the hæmoglobin was 60 per cent. with practically no changes in the number of blood cells. The serum bilirubin, September 2, was 1.8 mg. for each 100 c.c., direct reaction.

A letter from the patient's husband dated November 25, 1927, stated that she had been well and had gained from fifteen to twenty pounds. She had noticed some discomfort in the wound when doing unaccustomed work. Appetite was good and she was free of jaundice. Letters December 10, 1927, and January 13, 1928, stated that the patient continued to do well. She still had some tenderness at the site of the operation and some pain in the right hip, but was free of jaundice and itching.

CASE IV.—A man, aged sixty, was examined December 13, 1927. In 1923, he had had attacks of colic for four or five days which required morphine for relief. In 1924, he had had attacks of pain and was taken to a hospital and operated on, at which time he was told that the gall-bladder had ruptured and several large stones were removed from the abdomen. The gall-bladder was not disturbed and the patient made a good recovery. In the winter of 1926, he had another slight attack of pain lasting about a week. The urine was dark and stools clay-colored but there was no jaundice. In October, 1927, jaundice appeared for the first time. The onset and subsequent course were without pain or marked dyspepsia. He had lost twenty pounds. Pruritus had been severe early in the course of the jaundice but had disappeared.

*Examination.*—Icterus of skin and sclerotics was marked; hæmoglobin was 45 per cent.; the erythrocytes numbered 3,000,000 and leucocytes 6,300. The coagulation time was nine minutes and the urine contained bile, a few hyaline casts and an occasional red blood cell. A fairly free flow of bile was obtained by duodenal drainage. The serum bilirubin on admission was 11.5 mg. but decreased to 5.8 mg. Enlargement of the liver was not demonstrated and the gall-bladder was not palpable. During a period of seventeen days fever was intermittent and high. A clinical diagnosis was made of incomplete benign stricture of the common duct based on the fact that although stones were reported to have been found at the operation elsewhere, pain was not associated with the onset or course of the jaundice. Malignancy was not considered probable because there was a fairly free flow of bile into the intestine and the serum bilirubin decreased about 50 per cent. It was decided to operate when the serum level of the pigment had become stationary and after the usual intravenous administration of calcium chloride.

*Operation.*—January 19, 1928, a right rectus incision was made, thus securing an excellent exposure of the gall-bladder and the cystic and common bile-ducts. The common duct was approximately 2.5 cm. in diameter. The cystic duct was distended and dilated and the gall-bladder was distended. The walls of the gall-bladder appeared normal. Exploration of the pancreas showed an irregular, indurated tumor in the head forming a

mass approximately 4 cm. in diameter. An anastomosis was made between the common bile-duct and duodenum inasmuch as the common bile-duct lay directly on the second portion of the duodenum whereas the gall-bladder, because of the scarring from the former operation, lay at a much lower level (Fig. 2). Three rows of chromic catgut were used. An accurate anastomosis was made, at the conclusion of which the pylorus was held to the right of the median line by two interrupted sutures between the anterior wall of the stomach and the falciform ligament of the liver. Two Penrose drains were inserted.

Convalescence was uneventful with the exception that the day after the operation the temperature was 100.5°. The patient was dismissed from the hospital, February 1, and from the clinic February 6, at which time the wound was healed and the general condition excellent. The serum bilirubin was 1.7 mg. and stools were normal in color.

March 27, 1928, two months following operation, a letter stated that the patient had gained thirty pounds, that he had not been jaundiced, was feeling fine and eating everything.

CASE V.—A man, aged thirty-two, came to the clinic March 22, 1927, with a complaint of burn-
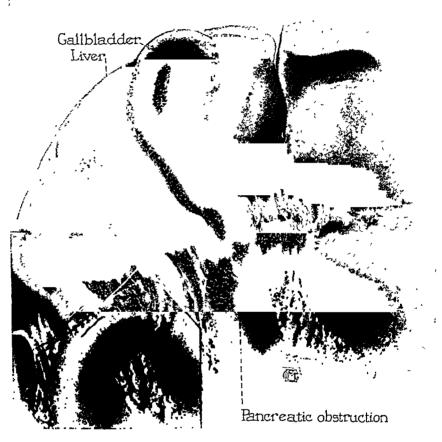


FIG. 2.—Choledochoduodenostomy.

ing in the stomach and red urine. The gastric trouble had affected him for six months and was more noticeable when the stomach was empty. Nausea and vomiting occurred occasionally, usually about half an hour after meals. He also experienced a sharp pain in the left epigastrium occasionally, at times a slight dull pain under the right costal margin, infrequent dull pain between the shoulder blades and sometimes pain across the back in the upper lumbar area. Six years prior to examination a severe epigastric pain had lasted three days and required morphine for relief. Three weeks prior to admission jaundice was noted. The onset was not associated with pain. The patient was an Italian who had been in America for five years. He had had malaria at the age of twelve and influenza at the age of twenty-one.

*Examination.*—There was tenderness in the right upper quadrant, the liver edge could not be felt, the spleen was not palpable, and icterus of the skin and sclerotics was marked. The stools did not contain parasites, ova or excess of fat; the urine showed a trace of bile and a few hyaline and granular casts. A fairly free flow of bile was obtained in duodenal drainage. The serum bilirubin, March 24, was 10 mg. and March 27, 5.3 mg. There was no anemia. Röntgen-ray examination of the stomach and duodenum did not show anything abnormal. Clinically there appeared to be an incomplete obstruction of the common duct, probably due to stones. This opinion was based on the degree of

pain, the behavior of the serum bilirubin curve, the associated dyspepsia and the fact that some bile was reaching the intestine.

Patient was under pre-operative preparation for six days during which time he received intravenous injections of calcium chloride.

*Operation.*—At operation, April 2, 1927, the head of the pancreas was found to be enlarged to about three times normal size. The remaining portion of the pancreas was lobulated and showed definite evidence of pancreatitis. The liver was enlarged and congested. The gall-bladder was enlarged and congested but did not contain stones. Cholecystgastrostomy was performed using two rows of chromic catgut anteriorly and posteriorly and surrounding the anastomosis with omentum. Two Penrose drains were inserted.

Convalescence was excellent with two degrees of fever on the second day. The patient was dismissed from the hospital April 18, and from the clinic April 28, at which time the wound was completely healed and the general condition excellent. The jaundice was disappearing but there was still slight itching.

The patient returned to the clinic June 13, complaining of burning in the epigastrium just below the umbilicus, before breakfast. He also complained of itching or burning in the rectum.

*Examination.*—There was no evidence of jaundice. The serum bilirubin June 14 was 1 mg. for each 100 c.c., indirect reaction. The blood was normal. Fractional test-meal showed total acidity 48, free hydrochloric acid 28, 150 c.c. of fluid at the end of an hour and a slight tinge of bile. The differential blood count on 200 cells showed 29.5 per cent. lymphocytes, 0.5 per cent. large mononuclears, 3.5 per cent. transitionals, 65.0 per cent. neutrophils and 1.5 per cent. eosinophils. The Wassermann reaction was negative.

A letter from the patient dated December 2, 1927, stated that his general condition was improving. He continued to have burning in the epigastrium before breakfast.

CASE VI.—A woman, aged fifty-one, registered August 29, 1927. For twenty-five years she had had recurring severe upper abdominal colic, the pain starting in the epigastrium and radiating around both costal margins. The attacks lasted for from one to several days and were succeeded by residual soreness over the upper half of the abdomen. Between attacks she felt fairly well but had a feeling of epigastric fullness after eating and occasionally regurgitated sour material and belched gas. Two months before registration a severe spell of upper abdominal colic had lasted two weeks; following this jaundice appeared with pruritus and acholic stools. Duodenal siphonage by her home physician had not resulted in recovery of bile. She had lost twenty pounds in weight in six weeks.

*Examination.*—The skin was bronze-colored, the sclerotics yellow, the epigastrium tender, the right lobe of the liver much enlarged, smooth and tender, and the gall-bladder palpable; the spleen was not felt; there was no ascites. The hæmoglobin was 68 per cent., erythrocytes numbered 4,280,000 and leucocytes 3,500. The urine contained bile but was normal otherwise. The blood urea August 30 was 30 mg. for each 100 c.c. The patient was hospitalized for observation. The serum bilirubin on three occasions was 11.5, 12.4 and 11.2 mg. for each 100 c.c. of blood. Duodenal siphonage did not recover bile. The coagulation time was seven minutes. There was no fever. The long history of colics followed eventually by persistent jaundice led to a diagnosis of cholecystitis with stones in the gall-bladder and the common duct. The question of associated malignancy was discussed because of the lack of appreciable fluctuation of pigment in the serum readings, the enlarged liver and the failure to obtain bile by duodenal drainage. An intravenous injection of 0.5 gm. of calcium chloride on each of three successive days was given.

*Operation.*—At operation September 10, 1927, a large tumor was found at the head of the pancreas which was so hard that the possibility of a stone in the common duct was considered, but the irregularity and the large size of the mass led to the diagnosis of carcinoma of the head of the pancreas. The gall-bladder was distended with very dark green bile. The common duct was dilated to approximately 4 cm. in diameter. Cholecyst-

gastrostomy was made using three rows of sutures anteriorly and posteriorly, the line of suture being protected with gastrohepatic omentum. Two Penrose drains were inserted.

Immediately following operation the patient ran a septic type of temperature with gastric retention from the first with a rapid drop in hæmoglobin. September 15, the hæmoglobin was 15 per cent. and the erythrocytes 8,400. A transfusion of 500 c.c. of blood was given immediately. The following day the blood count showed hæmoglobin 30 per cent. and erythrocytes 1,640,000. The blood urea September 14 was 214 mg. for each 100 c.c. of the blood, carbon dioxide combining power was 50 per cent. by volume and chlorides were 480 mg. for each 100 c.c. September 15, the blood urea was 247 and the carbon dioxide combining power 60 per cent. September 16, the blood urea was 241. The serum bilirubin was 19.9 mg. on September 9, 14.6 mg. on September 14, and 16.2 mg. on September 15. The patient died September 17, seven days after the operation. Necropsy showed carcinoma of the pancreas with occlusion of the pancreatic portion of the common bile-duct. There was a slight amount of local peritonitis and a small hæmatoma in the pre-peritoneal portion of the abdominal wall. From the time of the operation the urinary output was considerably decreased in proportion to the fluid intake.

CASE VII.—A Polish Jew, aged fifty-five, presented himself April 24, 1927, with a complaint of intense itching. Six years previously glycosuria had been discovered during an examination for life insurance. At that time he weighed 220 pounds. On dietary restriction his weight had been reduced to 165 pounds where it had remained for five years. During the last year he had lost an additional forty pounds. He was not aware of jaundice which was first detected at the clinic. The pruritus was of nine months' duration and had become very troublesome in the last three months. He had not had colic, but six or seven months before admission and on several other occasions he had had pain under the right costal margin and had treated it by the application of a hot water bag.

*Examination.*—The skin was dark and sclerotics slightly icteric. The liver was not enlarged; the hæmoglobin was 67 per cent., the erythrocytes numbered 3,770,000; the urine did not contain sugar but contained a trace of bile; the serum bilirubin on three readings over a period of ten days was 5.37, 5.0 and 6.7 mg. for each 100 c.c., the blood sugar was 0.13 mg. per cent. and a single duodenal drainage failed to secure bile. The diagnosis was indeterminate. The history of pain, the negative duodenal drainage, the associated diabetes and the intense pruritus seemed to warrant a search for obstruction in the bile-duct.

*Operation.*—At operation May 7, 1927, considerable enlargement of the head of the pancreas with moderate induration was found. The gall-bladder was distended to the shape of a gourd and its wall was thin. It was emptied with the trocar of its bile which was dark green and contained granules of bile pigment. The interior of the gall-bladder was explored with the finger; gall-stones were not found. Cholecystgastrostomy was performed anastomosing the gall-bladder to the stomach about 5 cm. above the pylorus. In the anastomosis three rows of sutures were used posteriorly and two rows anteriorly; the angle was protected by bringing gastrohepatic omentum about it.

The patient ran a variable fever from one to three degrees for the first four days after operation. The leucocyte count was 15,900 May 9, 12,000 May 10, and 9,500 May 12. He was dismissed from the hospital May 21, at which time the jaundice had slightly subsided but had not entirely disappeared. He was given treatment for subacute prostatitis and vesiculitis and dismissed from the clinic, June 17. A letter dated March 1, 1928, stated that the patient has not had any jaundice but itching has continued. He has also noticed light stools.

CASE VIII.—A man, aged fifty-nine, registered December 30, 1925. He had been quite well until the previous two months when he began to experience discomfort and distress after eating, with occasional pain in the right upper quadrant of the abdomen. The urine became colored and jaundice appeared a few days later and increased progressively. The stools were white. He had very little pain but severe itching of the skin and considerable nausea.

*Examination.*—Jaundice was graded 3. Tenderness in the epigastrium was present. The liver was enlarged and there was a resistant mass in the same region which could not be definitely identified as the gall-bladder. Urinalysis was negative. The blood count showed hæmoglobin 65 per cent., erythrocytes 3,700,000 and leucocytes 6,300. The serum bilirubin was 23.8 by the direct van den Bergh test. Coagulation time was seven minutes and forty-five seconds. A diagnosis was made of obstructive jaundice from a tumor in the head of the pancreas. The patient was sent into the hospital for observation and preparation for operation. During the ten days of preparation the serum bilirubin varied between 23.8 mg. and 25 mg. for each 100 c.c. The coagulation time was eight minutes and forty-five seconds on January 6. Calcium chloride was given intravenously during this time.

*Operation.*—At operation January 9, 1926, a tumor was found in the head of the pancreas. The gall-bladder was somewhat distended and its walls were slightly thickened and contained fat. The common duct was slightly enlarged but the walls were blue and did not show evidence of inflammatory change. Stones were not felt in the common duct or gall-bladder. Cholecystgastrostomy was performed and the anastomosis was protected by omentum. The bile was golden yellow.

Convalescence subsequent to operation was satisfactory. The blood urea January 25 was 31 mg.; carbon dioxide combining power was 56 per cent., chlorides 465 mg., and serum bilirubin 14.8 mg. The patient was dismissed from the hospital on the eighteenth day and allowed to return directly home.

The patient returned for reëxamination May 6, 1927, stating that following his dismissal he had had pruritus, chills and sweats and had lost twenty-five pounds. At the end of seven months he had lost forty-two pounds. He continued to lose weight until the spring of 1927, when he began to gain, his weight increasing from 133 to 148 pounds by April, 1927. Ten teeth with abscessed roots were extracted, bleeding continuing for thirty hours. At the time of his examination he had been free of chills and fever for one month. He had noticed abdominal swelling, clay-colored stools and itching with general abdominal distress three or four hours after meals; soda afforded some relief.

Jaundice, anemia, and cachexia were now graded 2. The systolic blood pressure was 100, the diastolic 68. The hæmoglobin was 40 per cent., erythrocytes 2,200,000 and leucocytes 6,100. Bile in the urine was graded 2. The serum bilirubin was 10.2; the coagulation time was ten minutes and the blood urea 12. The patient was allowed to return home May 10. A letter from his physician stated that the patient died August 1, of terminal bronchopneumonia complicating the biliary disease. He had marked jaundice before death and considerable pruritus. Necropsy revealed a moderately enlarged and very firm liver which was proved microscopically to be a hypertrophic biliary type of cirrhosis. Pancreas was slightly enlarged and rather firm from pancreatitis. Malignancy was not found in any of the organs which were examined.

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# SUBCUTANEOUS RUPTURE OF THE STOMACH; TRAUMATIC AND SPONTANEOUS

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SUBCUTANEOUS rupture of the stomach is the occurrence of gastric rupture without perforation of the abdominal wall. Perforated ulcers and such injuries as stab wounds, gunshot or other direct penetrations of the stomach wall are excluded.

Traumatic rupture of the stomach of this type is comparatively uncommon. Makin (1870) reported 282 cases of abdominal injuries, eighty-nine of which had rupture of internal viscera with not one gastric rupture. Neuman * likewise mentions no gastric rupture in fifty-four reported cases of ruptured abdominal viscera. Petry (1896) in a much larger series reported 219 cases of rupture of the gastrointestinal tract. Twenty-one were in the stomach (thirteen traumatic and eight spontaneous), 163 were in the small intestines and twenty-six in the large intestines. Particular interest can be attached to the cases associated with severe trauma and little or no external evidence, but when rupture of the stomach occurs with very slight or even no external trauma it becomes of far greater importance from a surgical as well as medico-legal aspect.

We have made a survey of the literature and have divided the cases of subcutaneous rupture of the stomach into three main groups: those following severe and moderate traumata, those following slight trauma and the spontaneous ruptures.

*Severe and Moderate Trauma.*—We collected from the literature thirty-one cases of subcutaneous gastric rupture after severe and moderate traumata. Twenty-one or 65.6 per cent. showed other injuries, mostly internal. The spleen is the organ most often injured in association with rupture of the stomach: seven cases or 22 per cent., and almost as frequent is the liver—six or 18.7 per cent.

To the thirty-one cases collected we add the following which will be described briefly:

CASE No. 1.—A laborer, age thirty-three years, was admitted to Mount Sinai Hospital, October 17, 1924, with a history of having been struck across the abdomen with a plank. He was in profound shock, pallid, restless, with rigid abdomen and shifting dulness in the flanks. There was an abrasion of the skin of the abdomen on either side of the umbilicus. At operation, soon after the accident, a rent running transversely four inches in length was found in the fundus of the stomach, on the anterior surface. The abdominal cavity was filled with blood and gastric contents. The patient died fifteen hours after operation.

At autopsy, in addition, a laceration of the renal surface of the spleen 2 centimetres in diameter was found.

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* From Eisendrath.

*Mechanism and Type of Injury.*—Rupture of the stomach occurs in these cases in one of three ways—by bursting, by crushing or by tearing. Force may act directly or indirectly and may be diffuse (run over, crushing, fall from height) or circumscribed (kicks, blows or fall on object). It is difficult to predict from the type of injury the exact mechanism of rupture. In a diffuse injury with crushing of the external body, we expect a crushing injury to the stomach, but instead, especially if the stomach be filled, a bursting type of rupture may occur. In the localized type of injury instead of being crushed against the spinal column, the stomach may burst like a paper bag which is struck when blown up. Only if there is evidence of rupture of the anterior and posterior wall opposite each other in direct line with the spinal column, can a crushing mechanism be diagnosed with certainty. There are five cases of this kind in the first group (diffuse injury Table I), and three in the second group (localized injury Table II). Several of the others are possibly of this type also. Tearing of the stomach may occur, for example, when the abdomen is struck by an object which catches the greater omentum and carries it distally; or in a fall from a great height, the stomach, at the moment of impact, is carried on by its own momentum and tears at its attachments. Because of the difficulty of separating the cases of this group according to the mechanism of injury, we have arbitrarily divided them into those due to localized, and those due to diffused traumata.

The diffuse type of injury is the more common; twenty-one or 65.6 per cent., and it is in this type of injury that other organs are prone to be injured at the same time. This is probably due to the force or impact acting at several points, thereby allowing a greater opportunity for other structures to be involved. Of twenty-one cases with diffuse type of trauma, sixteen or 76.2 per cent. had other injuries, whereas of eleven cases with circumscribed type of trauma only six or 54.5 per cent. had other injuries and three of these consisted only of ruptured recti muscles. The internal organs were injured in thirteen or 62 per cent. of the former type as against two or 18 per cent. of the latter type of injury. Rupture of the liver or spleen occurred in eleven or 52 per cent. of the first group and only in two cases of the second group.

Incomplete rupture of the stomach may occur as shown in the cases of Poland, Ziegler and Clayton. Duplay cites, as examples, of mucosal tears, three cases which after insults to the abdominal region vomited blood, but spontaneous healing occurred in all. Hoffmann cites four cases of mucosal tears and Leube reports one. This, however, brings up the question of traumatic ulcers, a subject that will not be discussed in this report.

External evidence of injury is more often encountered in the circumscribed type, five of eleven cases; in the diffuse type only three. The lack of this evidence seems almost incredible with the types of injury which were sustained in some of the cases. The following report exemplifies: *

A male, nineteen, was run over by three carriages, brake, van and engine. The latter weighed thirty tons. There was not the smallest wound on the body and only

* British Med. Jour., August 20, 1870, vol. ii, p. 185.

a few abrasions of the cuticle across the abdomen. At autopsy the abdominal muscles, back muscles, right kidney, transverse colon, ileum and body of the third lumbar vertebræ were found cut across, but the skin showed only abrasions and ecchymoses.

The outstanding symptoms are those of shock which is usually marked. Abdominal pain, rigidity and tenderness are generally present. Of twenty cases giving symptoms, thirteen had vomiting. Nine cases vomited blood and in two other cases blood trickled from the nares. This may or may not have come from the stomach. Vomiting of blood has always been stressed as a prominent symptom. In the above cases it occurred at least in 50 per cent.

The exact site of rupture is often not stated in the records. In twenty-one reports the location was described. Fourteen of these, or two-thirds, were in the region of the pylorus. This is undoubtedly because of the greater degree of exposure to trauma that this site offers and its situation over the spinal column. The anterior wall was affected in seventeen of the twenty-four cases in the reports in which the surface was mentioned. The greater and lesser curvatures were equally involved five times. The lesser curvature and cardia which are well protected are probably involved only in the bursting type of rupture. In this type of rupture other rents may be present. These are often incomplete tears and might be overlooked (case of Clayton).

The prognosis depends on many factors among which may be mentioned (1) the severity of trauma, (2) injury to other organs, (3) shock, (4) blood loss, and probably of most importance is (5) the time of operation after the injury. Before laparotomy came into general use (1890), death was practically always the outcome in complete ruptures. Now, with early operation, the prognosis becomes much better. A small percentage recover spontaneously. Especially is this true of incomplete or mucosal rupture. (Duplay, Hoffmann, Leube.) The case of Rose showed evidence of spontaneous subsidence by adhesion to the liver in which an abscess developed. Poland and H. Brush cite cases of gastric fistula following trauma and Ettmuller * cites two cases of abdominal trauma with rupture of stomach and resultant spontaneous cure by the development of gastric fistulæ. Of eleven cases operated seven recovered and four died; three of the eleven were operated two to four weeks after the accident. Spontaneous healing had occurred to some degree and the laparotomy was done to correct the complication which had arisen, such as hæmatoma of stomach wall and abscess formation, and not primarily to suture the rent. Of eight operated soon after the accident four died; of these one case had an incomplete tear (tear of mucous membrane) which was not found at operation and a rent in the spleen was overlooked in another case. In the remaining two the length of time from the accident until operation is not stated. However, early operation should cut down the mortality of these cases.

*Rupture Due to Slight Injury.*—The occurrence of rupture of the stomach after severe abdominal injuries is, as noted, infrequent. This, however, seems

* O. Marchetti.

well accounted for by the protected position of the greater part of the stom-ach. More surprising by far are those cases in which rupture of the gastric wall occurs after a slight trauma apparently out of all proportion to the lesion.

CASE No. 2.—A boy, aged six, following dinner which consisted largely of beans ran after his father, tripped and fell. He experienced marked abdominal pain, was admitted to Mount Sinai Hospital one and a half hours after the accident, March 19, 1927, and presented a picture of shock. He was pallid, the respirations were rapid, his pulse was 160 and thready. There was a lacerated wound of the forehead. The abdo-men was distended, tender; liver dulness was obliterated and shifting dulness was present in the flanks. He was tender per rectum and fulness was felt in the cul-de-sac. There was no external signs of injury to the abdomen. Laparotomy was immediately performed. The abdominal cavity contained undigested food (beans) and stomach con-tents but very little blood. A three and one-half centimetre rent in the anterior wall of the stomach near the greater curvature running parallel to it was found and sutured. The shock increased and in spite of a transfusion and stimulation, the child ceased seven and a half hours after the operation. Autopsy about six hours later by Dr. Klemperer revealed the following as taken from the protocol:

"A well-nourished, well-developed, white child of about six years of age. Rigor mortis is present and there is post-mortem lividity on the back and dependent portions. There is a deep laceration, 2.6 centimetres long with sharp, gaping edges on the left forehead, which extends down to the bone and through the periosteum. The underlying bone, however, appears normal. There is an excoriation of the skin on the right elbow. There is a very insignificant subcutaneous extravasation of blood in the left side of the thorax in the mid-axillary line at the eighth rib, about the size of a pea, irregular and bluish-red in color.

The abdominal cavity contains about 200 cubic centimetres of fluid and a very large amount of partially digested lima beans. The parietal and visceral peritoneum is red-dened, the blood vessels are injected, but the peritoneum is glistening. The parietal pleura, at the costo-chondral junction of the eighth rib on the left, shows an irregular, subpleural hæmorrhage of the size of a dime. A small subpleural hæmorrhage is found in the diaphragm on the left side.

*Stomach.*—There is a lacerated wound 3 centimetres in length in the anterior wall of the stomach nearer to the greater curvature, closed by sutures. There is another perforation 1 centimetre long and unrepaired in the anterior wall of the fundus at the level of the cardia. Within the sub-mucosa of the fundus there are diffuse extravasations of blood which shine through the mucosa. The stomach contains partially digested beans, but no blood.

*To Summarize.*—A boy of six, shortly after dinner tripped and fell. He was brought to the hospital in a condition of shock, with a laceration of the forehead and no other signs of external traumata. A laparotomy revealed a laceration of the stomach which was sutured. The patient died and at autopsy a second laceration of the stomach was disclosed and as evidence of external trauma to the abdomen only an insignificant bluish-red area in the left axillary line."

A review of the literature for similar cases reveals eight reports which are tabulated in Table III.*

In all the cases collected, the trauma was slight and such as is encountered daily. Some of these cases were reported by their original authors and by subsequent writers as examples of spontaneous rupture, but we prefer to

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* Arrot's case has not been included in our series because of insufficient data. He cites the case of a small boy who fell a short height from a ladder. There was no exter-nal mark but a large rent was found in the stomach.

include them under "simple trauma" if there is a history of such, no matter how slight. The mechanism here is undoubtedly somewhat allied to spontaneous ruptures which will be discussed more fully under that heading. Two points to be considered are: 1, whether the stomach is normal or diseased; 2, the effect of distention.

There is very slight indication of the importance of a preëxisting pathological condition in these cases. However, it is self-evident that very slight trauma may cause a perforation of a diseased stomach wall. Reports of such incidents are not so rare. Perforation of gastric ulcer after slight trauma often takes place. Marianschik reports rupture of a gastric ulcer by a jump of three feet from wagon to ground. Ambrose describes a case of ruptured gastric ulcer by bending over, drilling with an auger, and Dubs reports volvulus and rupture of gastric ulcer in a diaphragmatic hernia.

As examples of perforation of carcinoma following slight trauma to the stomach, we briefly give the following: Strassmann reports the case of a man with carcinoma of the stomach who, after lavage, collapsed. At autopsy a rent two inches long was found in the middle of the lesser curvature and parallel to it. The surrounding region was discolored, dark red, and the stomach wall was thin. The carcinoma began three inches below the tear. Strassmann thinks there was first a rupture of a small vessel. It is noteworthy that the perforation need not be at the site of the neoplasm. In a case reported by Morrison, two rents, parallel, one inch each, were found extending through the carcinomatous area which was in the pyloric region.

Distention was present quite consistently (Table III). In the first two cases which were under the influence of opium the stomach had been distended by lavage. In the third case there was distention attributed by Revilliod to nervousness (nervous distention). The fourth case had distention associated with chronic gastritis. The other cases had food in the stomach besides such gases and secretions which may have accrued.

Failure of the contents of the stomach to pass through the pylorus or cardia at the moment of injury certainly accounts for the fatal increase in tension which leads to rupture. This is due to the tonicity of these openings which is controlled by a nervous mechanism and is not easily and suddenly overcome. The normal tonicity may be further increased by cardiospasm or pylorospasm. At the cardia a passive valve closure (Kelling), or at the pylorus an artery-mesentery obstruction (Albrecht), may take place. Angulations, fixations, or pressure of a dilated duodenum (Busch) act in the same way.

In two of the cases (4 and 5) a sudden increased intra-abdominal pressure seems to have had some additional bearing. By bending over, the diaphragm is splinted and the abdominal muscles become tense. The intraperitoneal space decreased and the intra-abdominal pressure proportionately increased. Sauerbruch thinks this is of great importance and accounts for most so-called spontaneous ruptures. H. Brush cites a case of a male, twenty-three, who after a heavy meal attempted to lift a large stone. He felt pain in

the stomach region and suffered until death, some years later, from pain and vomiting. At autopsy, a fistulous opening was found at the pyloric end of the stomach on the posterior surface opening into the pancreatic duct.

The mechanism of rupture has been likened to a distended toy balloon which when slightly filled will withstand considerable trauma, but when distended will rupture very readily and with little trauma. Max Busch draws attention to the factors of tonic and atonic dilatation and concludes that rupture occurs more frequently in the first type.

Finally, we must not lose sight of the fact that what may appear on the surface to be but a trivial injury may really be of considerable degree. When, as in case six, a boy goes coasting with his sled and alights on it "belly first", his abdomen receives the brunt of the fall and practically his entire weight or its equivalent in force may be exerted on the stomach.

Of these cases only one was operated upon. Unfortunately a second rent was overlooked and the patient died. Of those unoperated, none recovered. If it is only kept in mind that rupture of the stomach can occur with apparently little trauma, even though rarely, early diagnosis can be made and operation advised. The history of a patient having eaten a large meal or distention preceding the trauma is common. A valuable aid to diagnosis is the X-ray, which will often reveal air subdiaphragmatically.

*Spontaneous Rupture.*—The question of spontaneous rupture of the stomach has been discussed for a long time and Percy and Lerent (1819) devote several pages to the discussion and cite numerous cases. However, Andral (1831) though mentioning spontaneous rupture in animals has not seen a true case in human. He already believed that the cases reported had occurred in diseased stomachs. Even as late as the nineteenth century spontaneous ruptures of the healthy stomach in man were thought to be frequent. This is easily understood. Not until 1829–35 did Cruveillier describe ulcer of the stomach and its perforation. Lefévre (1842) takes up the question and collects eight cases including one of his own. These cases, however, are not very convincing and the preëxistence of an ulcer cannot be ruled out. Later on with increasing critical investigation, the number of case reports becomes very small. Orth does not believe that a healthy stomach can rupture. MacCallum, Delafield and Prudden, Aschoff and Kaufmann do not even mention such an occurrence, whereas Hauser devotes a full chapter to the question. We collected critically the observed cases of the literature which are tabulated in Table IV.*

Before discussing them we would like to review in brief the experiments which have been undertaken by various authors to cast light on the subject.

LEFÉVRE (1842–1859) filled stomachs and compressed them to see where the tears occur. He found that they occurred mostly in the fundus and that the serosa tore first. But when filled with air, emphysema of the stomach wall occurred in the lesser curva-

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* It is well known that rupture of the stomach often takes place in ruminating animals after feeding on fresh clover from the development of carbonic acid gas from fermentation of contents of the pouch.

ture nearer to the cardia, *i.e.* the mucous membrane tore first. He observed spontaneous ruptures in animals and concludes that it may occur in human beings.

REVILLIOD (1885) found that the stomach would hold 4,000 cubic centimetres before rupture and that the rents occurred in mid-stomach, both anterior and posterior walls.

KEY ABERG (1897) filled the stomachs in situ of corpses in a sitting position, having the abdominal wall both open and closed. He used a funnel and rubber tube via the œsophagus. When the funnel was held three-quarter metres above, only 4,000 cubic centimetres would enter the stomach, but when the funnel was raised one to one and one half metres above, he could put in as high as 5,000 to 6,000 cubic centimetres before the stomach burst. At the end of 4,000 cubic centimetres he regularly found ruptures in the mucous membrane along the lesser curvature and parallel to it. With greater filling stellate tears occurred at cardia and he often found tears of the serosa before complete rupture occurred. The site of the rents he feels is due not to the anatomical structure, but to the form which the stomach assumes. It is an inverted cone with a convexity at the lesser curvature. With distention or filling, the stomach tends to assume the shape of a sphere. Thereby the lesser curvature has the greatest excursion, that is, it must stretch the most and thus tears more frequently at this site.

FRANKEL (1906) investigated by experiments the elasticity in various parts of the stomach. Using E as the cöefficient of elasticity, he utilized the formula E equals $\dfrac{Pi}{Q\lambda}$ where i equals the length of the examined strip, P equals the load, $\lambda$ equals lengthening or degree of stretching, and Q equals the cross section. He used stomachs of dogs, children and adults. He concludes that the elasticity of the stomach wall depends upon the elasticity of the muscular coat. The elasticity cöefficient of the mucosa is less than that of the muscle; with equal loads the stretching at either curvature is greater crosswise than lengthwise and that the neighborhood of the lesser curvature has a lesser cöefficient of elasticity than the rest of the stomach. Besides the resistance of the muscle, he maintains that the form of the stomach and absence of mucosal folds on the lesser curvature play a rôle in the production of ruptures. As a practical point he offers the statement that he could not produce a complete rupture of a child's stomach by distention with fluids from ordinary funnel and tube.

TALMA (1890) experimenting with rabbits found with marked distention he obtained ulcers, areas of softening and infarcts in the fundus, also diffuse hæmorrhagic infiltration and in other place localized bleeding. A small amount of HCL sufficient to change hæmoglobin to hematin caused necrosis and ulcers. The presence of HCL alone was not sufficient to cause hæmorrhage or necrosis.

MURDFIELD (1926) on filling the stomachs of corpses quite early after death with 2–3 litres of weak HCL and subsequently adding a little soda bicarbonate, regularly produced rupture in apparently normal stomachs, of the mucous membrane at least.

In discussing the human cases of spontaneous rupture, we must first of all take into consideration again the question of distention and its effects on the stomach. That distention plays a primary rôle in spontaneous rupture cannot be denied. The mere mechanical factor of acute distention, however, is not sufficient. There are other contributing factors which must be considered. The first question to be asked is, why the overfilled stomach does not empty itself normally before the limits of its elasticity are reached. This may be due to a mechanical or functional obstruction. Passive valve closure in which the overfilled fundus compresses the œsophagus at the cardia (Albrecht and Kelling) and other mechanical factors previously mentioned may take place or failure of the stomach to empty might be purely functional in char-

acter. One can assume a direct influence of the distention upon the nervous mechanism of the gastric wall whereby the nerve endings or the plexus within the wall become paralyzed. The fact that some cases of spontaneous rupture occur in insane might point to the possibility of a central nervous influence. Such a conception finds support in the experiments of Braun and Seidel, who found that in narcotized dogs eructation and vomiting failed to occur even though the stomach was filled to an extreme degree. Nor did it occur when the vagus nerve was cut. From these considerations one can presume that a stomach once overfilled by food which is capable of fermentation will continue to dilate due to the further accumulation of gases and that finally the limitations of elasticity are reached.

On the other hand, the elasticity may be affected by acute local changes within the stomach wall. Distention interferes with the circulation, produces ischemia and the nutrition of the wall suffers. There are a few cases reported of rupture of the stomach with brown softening of the wall which is considered intravital (Leube and Meyer, Kundrat and Froeboese). That such vital autodigestion caused by distention may occur is evidenced by the experiments of Talma. He produced acute distention of the stomach in rabbits by ligation of the duodenum. After sixteen hours the animal was killed. The stomach showed numerous hæmorrhages; in addition, however, a rupture at the greater curvature within an area of brown softening of the wall.

Several of the cases have a history of gastric rupture while attempting to vomit or during the act of vomiting. Bedamie, in 1836, thought that spastic contractions which occur when the stomach is filled ordinarily produce vomiting, but in rare cases cardiospasm prevents this and the wall ruptures. Hutyra and Marek think that rupture often occurs in horses by violent contraction of the gastric musculature with intense increase in intragastric pressure.

A few of the cases give evidence of associated slight pathology. In the case reported by Chiari there is a scar in the wall of the stomach. In Hoffmann's case the stomach showed thick walls. Such observations lead to those cases in which rupture occurs in stomachs affected by ulcer or neoplasm which naturally assume a different aspect.

The cases of Daxenberger, Lantschner, and we might include a case of Rokitansky, are examples of spontaneous rupture of the stomach within a hernia. It is not untenable to believe that some damage may have ensued from this abnormal situation.

The site of rupture is often not specifically localized in the reported cases. But five definitely locate the rent on the lesser curvature. This area has been shown experimentally to be generally the first to give way. Those cases reported of intravital digestion have the rent in a situation other than the lesser curvature, which further substantiates their concept of antemortem digestion.

Subcutaneous emphysema was present in four cases and, as stated, usually occurs in the spontaneous ruptures rather than in those due to severe trauma.

Only two of the cases were operated upon. The one (Versé) in which laparotomy was performed about twenty-four hours after the occurrence of the rupture, died; the other (Steinman) in which operation was done soon after the accident, recovered.

TABLE I.

*Severe and Moderate Trauma. Diffuse Injuries.*

POLAND: Guys hospital reports, vol. iv, p. 132, 1858. Female, aged nine. Type of trauma.—Run over abdomen by wagon wheel. Symptoms.—Abdomen tender, irritable, restless. Vomited dark material. Signs of external injury.—None. Stomach: size and site of rupture.—Mucous membrane torn and bruised. Internal injuries.—Rupture of liver. Stomach before trauma.—Normal. Procedure and result.—Died, nine hours.

ROCQUES: Soc. de Med. (Poland), 1858. Male, adult. Type of trauma.—Fell from first floor to pavement. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Six-inch rent at cardiac end of stomach on greater curvature. Internal injuries.—None mentioned. Procedure and result.—Died, three hours.

COLLINS: Boston Med. Jour., vol. lxxii, p. 202, 1866. Male, aged thirteen. Type of trauma.—After heavy meal fell twelve feet; tree to ground. Symptoms.—Abdominal pain and tenderness. Attempts at vomiting. Signs of external injury.—None. Stomach: size and site of rupture.—Two-inch rent near pylorus, anterior wall. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, nine hours.

BUIST: Amer. Jour. Med. Sci., vol. lx. p. 575, 1870. Male, adult. Type of trauma.—Fell twenty feet, shoulder struck plank ten feet above ground. Symptoms.—Pain in abdomen. Vomited small amount of blood. Signs of external injury.—None. Stomach: size and site of rupture.—Five-inch rent at pylorus extending into duodenum, posterior surface. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Died, fourteen hours.

MOXON: Brit. Med. Jour., vol. ii, December, p. 617, 1870. Male, boy. Type of trauma.—Run over by carriage. Symptoms.—Not given. Signs of external injury.—Slight. Stomach: size and site of rupture.—Stomach cut across as by knife. Internal injuries.—Not mentioned. Stomach before trauma.—Normal. Procedure and result.—Not noted.

MURCHISON: Report Path. Soc. London, Brit. Med. Jour. II, 617, 1870. Adult. Type of Trauma.—Train wreck. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—One and one-quarter-inch rent, knife like, middle of greater curvature. Internal injuries.—Rupture of diaphragm and liver. Procedure and result.—Died, immediate.

LUNN: Trans. Path. Soc. London, Bd. 34, p. 81, 1883. Male, aged four. Type of trauma.—Run over. Symptoms.—Much pain and blood trickled from left nostril. Signs of external injury.—None noted. Stomach: size and site of rupture.—Two complete tears one inch in diameter at commencement of greater curvature. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, four hours.

ERICHSEN'S SURGERY, p. 321.* Male, adult. Type of trauma.—Crushed between wagon and post. Symptoms.—Vomited meal but no blood. Signs of external injury.—None. Stomach: size and site of rupture.—Almost completely across at pylorus. Internal injuries.—Rupture of liver and spleen. Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

ROHNER: Mem. de la Soc. Med. de Nancy Coillot 7, 1879. Male, aged thirty-eight. Type of trauma.—After heavy meal fell from height (twenty metre). Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Rent on anterior wall near pylorus and lesser curvature. Internal injuries.—Multiple fractures. Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

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* Rehn.

STOICESCO: Bull. Soc. Anat. de Par. xlviii, p. 403, 1873. Age not given. Type of trauma.—Fell from considerable height. Symptoms.—Not given. Signs of external injury.—Not noted. Stomach: size and site of rupture.—Rent in anterior wall. Internal injuries.—Rupture of liver, sternum and ribs. Stomach before trauma.—Normal. Procedure and result.—Not noted.

ZIEGLER: Munch. Chir. Klinik. Male, aged twenty-three. Type of trauma.—Crushed between two railroad cars. Symptoms.—Shock, pain, vomiting blood. Later tumor and symptoms of obstruction. Signs of external injury.—None. Stomach: size and site of rupture.—Incomplete, anterior wall (large cyst formed, contained 3 litres dark fluid). Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Operation, three weeks. Recovery.

THIERY: Bull. Soc. Anat. de Paris, vol. lxiv, p. 352, 1889. Type of trauma.—Fell three stories alighting on hip. Signs of external injury.—About pubis. Stomach: size and site of rupture.—One-inch rent along greater curvature in anterior wall. Internal injuries.—Rupture of bladder, fracture os pubis (ramus). Stomach before trauma.—Normal. Procedure and result.—Died, five hours.

WILSON: (Rehn), 1887. Type of trauma.—Run over by wagon wheel. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Two-inch rent about two and one-half inches from pylorus, anterior wall. Internal injuries.—Rupture of liver. Procedure and result.—Died, three hours.

ANDREWS: Tr. Glasg. Path. and Clin. Soc., vol. v, 1893. Male, aged seventeen. Type of trauma.—Crushed between cart and wall. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—One-inch rent two and one-half inches from pylorus, anterior wall. Serosa tear middle anterior wall. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Died, eight hours.

REHN: Arch. f. Klin. Chir. Bd. 53, p. 383, 1896. Female, aged nineteen. Type of trauma.—Fell from balcony. Symptoms.—Shock, marked abdominal pain. Vomited blood. Signs of external injury.—Lacerated forehead. Stomach: size and site of rupture.—Three rents, incomplete, one and one-quarter inches, two inches anterior midstomach. One rent posterior. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation five hours. Recovery.

CLAYTON: Brit. Med. Jour., vol. i, p. 634, 1894. Male, aged sixteen. Type of trauma.—Crushed between buffers of two railroad trucks. Symptoms.—Shock, pain in abdomen. Vomited small amount of blood. Signs of external injury.—Slight abrasion. Stomach: size and site of rupture.—Mucosa torn in two places, midstomach, anterior and opposite posterior. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Died, twenty-one hours.

ROSE: Freie Vereinigung der Chirurgen, 34–12, 1922. Male, aged twenty. Type of trauma.—Fell from roof, three floors. Symptoms.—Abdominal tenderness and bloody vomitus. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in anterior wall of stomach; adhesion to liver with abscess in left lobe. Internal injuries.—Fracture base of skull. Procedure and result.—Operation in one month. Recovery.

WILDEGASS: Arch. f. Klin. Chir., 122–276, 1922. Male, aged eight. Type of trauma.—Run over by automobile. Symptoms.—Not given. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in pyloric region. Internal injuries.—Rupture of pancreas and liver. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Recovery.

NEUBERGER: Wien. Klin. Wochenschrift, 36:849, 1923. Male, adult. Type of trauma.—Fell from great height; landed on face and abdomen. Symptoms.—Shock. Dried blood present about nares. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in prepyloric region, anterior wall and crushing of posterior wall. Internal injuries.—Fracture of right ethmoid retroperitoneal hæmatoma. Stomach before trauma.—Normal. Procedure and result.—Operation nine hours later. Died, twenty-four hours.

MINOR: N. Y. Med. Jour., vol. xlv, p. 360, 1887. Male, aged ten. Type of trauma.—Run over by heavy truck. Symptoms.—Shock, pain region bladder. Vomiting. Frequent desire to urinate. Signs of external injury.—None. Stomach: size and site of rupture.—Rent in lesser curvature. Internal injuries.—Rent in ileum. Stomach before trauma.—Normal. Procedure and result.—Died, twelve hours.

GLASSMAN: Male, aged thirty-three. Type of trauma.—Struck across abdomen by plank. Symptoms.—Shock, rigid abdomen, fluid in flanks. No vomiting. Signs of external injury.—Abrasion skin. Stomach: size and site of rupture.—Four-inch rent in fundus, anterior wall. Internal injuries.—Rupture of spleen. Stomach before trauma.—Normal. Procedure and result.—Operation, three hours. Died, fifteen hours.

TABLE II.

*Severe and Moderate Trauma. Localized Type of Injury.*

POLAND: Guys Hospital Reports, vol. iv, p. 123, 1858. Male, adult. Type of trauma.—Struck on right side by shaft of dray. Symptoms.—Not mentioned. External injury. None noted. Stomach: size and site of rupture.—Tear in serosa only. Internal injuries.—Rupture of spleen and fracture of two ribs. Stomach before trauma.—Normal. Procedure and result.—Died, eight hours.

POLAND: The same, 1858. Male, aged ninety. Type of trauma.—Maltreated and mauled. Symptoms.—Vomited blood for three days. External injuries.—None. Stomach: size and site of rupture.—Rent size of sixpence on anterior wall. Internal injury.—None. Stomach before trauma.—Normal. Procedure and result.—Died, five days.

PARRY: Austral. Med. Gaz., vol. vii, p. 251, 1888. Male, aged sixty. Type of trauma.—Struck in region of abdomen following explosion. Symptoms.—Marked abdominal pain and thirst. External injuries.—Superficial wounds, fractured hand. Stomach: size and site of rupture.—Four and one-half inch irregular rent on anterior wall. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Died, four hours.

GROFF: Med. and Surg. Reports, vol. 67, p. 1000, 1892. Male, aged fifty. Type of trauma.—After breakfast, kicked in the abdomen by a horse. Symptoms.—Mild shock, marked abdominal pain. Vomited. External injuries.—Hæmorrhage about umbilicus. Stomach: size and site of rupture.—Two-inch rent near lesser curvature, anterior wall nearer to pylorus. Internal injuries.—None noted. Stomach before trauma.—Normal. Procedure and result.—Died, sixteen hours.

LIMONT and PAGE: Lancet, July 9, 2-84, 1892. Male, aged thirty-one. Type of trauma.—Hard blow in pit of stomach by "bogie." Symptoms.—Pain and vomiting. Stomach: size and site of rupture.—Rent in anterior wall near pylorus. Internal injury.—None. Stomach before trauma.—Normal. Procedure and result.—Spontaneous recovery; resection of scar later.

MARCHETTI: La Clinica, vol. ix, p. 292, 1903. Male, adult. Type of trauma.—Thrown against wooden plank. Symptoms.—Not given. External injury.—None. Stomach: size and site of rupture.—Two-inch rent, pylorus, lesser curvature, posterior wall (irregular rent opposite) directly over vertebra. Internal injury.—Lacerated left rectus muscle. Stomach before trauma.—Normal. Procedure and result.—Operation, ? hours. Recovery.

WEEKS: J.A.M.A., vol. lxvii, p. 1294, 1916. Male, aged thirty-five. Type of trauma.—Steering wheel struck pit of stomach with great force. Symptoms.—Symptom of perforation. External injury.—None. Stomach: size and site of rupture.—Entire thickness at pylorus cut from lesser to greater curvature. Internal injury.—Posterior sheath of rectus lac. Stomach before trauma.—Normal. Procedure and result.—Not given.

IPSON: Norsk. Mag. f. Laegevidensk, vol. 83, p. 514, 1922. Male, aged twenty-three. Type of trauma.—Handle bar of bicycle struck abdomen during collision. Symptoms.—Mild shock, marked abdominal pain. No vomiting. External injury.—Abrasion below

right ribs. Stomach: size and site of rupture.—One cm. rent pars pylorica near greater curvature. Internal injuries.—None. Stomach before trauma.—Normal. Procedure and result.—Operation, few hours. Recovery.

PIANCASTELLO: Riforma Med., vol. 38, p. 1038, 1922. Male. Type of trauma. —Thrown against cart shaft while riding bicycle. External injuries.—Abrasion and contusion, R. U. Q. Stomach: size and site of rupture.—Complete division mid-stomach into two halves, edges regular. Internal injury.—Rupture of recti. Stomach before trauma.— normal. Procedure and result.—Operation. Died, seventeen hours.

ROSE: Deut. Zeitschr. f. Chir. 34, S. 12, 1892. Male, aged twenty-four. Type of Trauma.—Fell and struck left hypochondrium on edge of truck. Symptoms.—Vomited bloody material (later tumor appeared in upper abdomen). External injury.—Contusion. Stomach: size and site of rupture.—Two-inch rent in posterior wall. Internal injury.— Rupture of pancreas. Stomach before trauma.—Normal. Procedure and result.—Operation, fourteen days later. Recovery.

JACKSON: Lancet, vol. i, p. 425, 1884. Male, aged seventeen. Type of trauma.— Emery wheel broke. Large piece struck abdomen. Symptoms.—Collapse, coffee ground vomitus, blood-streaked. External injuries.—Lacerated face, legs and hematoma of scrotum. Stomach: size and site of rupture.—Two rents; two-inch rent pylorus, lesser curvature, posterior wall and one-inch rent (mucosa and serosa only) near pylorus anterior wall. Internal injury.—Blood clots in omental folds. Stomach before trauma.— Normal. Procedure and result.—Died, eight and one-half hours.

TABLE III.

*Slight Trauma.*

KEY ABERG: Gerichtl. Med. III F. S. 42, 1891. Male, aged fifty-two. Opium user. Nature of trauma.—Stomach lavage following 1 grain of opium. Symptoms.—Symptom of opium poisoning, nausea, cyanosis, coma, reddish fluid from stomach. External injury. —None. Stomach: size and site of rupture.—Several mucosa tears, about ten, in lesser curvature. Stomach at autopsy.—Distended, mucosa injected and flecked with red areas. Internal injuries.—None. Procedure and result.—Died, six hours.

STRAUSSMAN (FRANKEL): Deut. Arch. f. Clin. Med., vol. lxxxix, p. 113, 1906. Male, adult. Opium user. Nature of trauma.—Stomach lavage. Symptoms.—Not given. External injury.—None. Stomach: size and site of rupture.—Lesser curvature, central part about twelve mucosa tears. Internal injuries.—None. Procedure and result.—Died.

REVILLIOD: Revue Med. de la Suisse Romande Nr. 1, vol. 85, ii, p. 193, 1885. Female, aged twenty-eight. Domestic. Nature of trauma.—Fell to the floor. Symptoms.—Abdominal pain, nausea (no vomiting). Subcutaneous emphysema. External injury.—None. Stomach: size and site of rupture.—Three-inch rent, posterior wall, fundus, lesser curvature. Three-inch rent of serosa, centre of anterior wall. Stomach at autopsy.—Markedly distended. Internal injuries.—None. Procedure and result.—Died, two and one-half hours.

MATTIEUX: West. Med. Reporter, Chicago, vol. ix, p. 274, 1887. Female, aged fifty-six. Housewife. Nature of trauma.—Reaching for vessel under bed. Symptoms.— Felt sudden great pain and something give way. External injury.—None. Stomach: size and site of rupture.—Two-inch rent at pylorus. Stomach at autopsy.—Chronic gastritis. Internal injuries.—None. Procedure and result.—Died, third day.

WILSON: Indiana Med. Jour., vol. viii, p. 234, 1889. Female, aged thirty-three. Mother of five. Nature of trauma.—Jumped from high board fence after hearty meal. Symptoms.—Intense abdominal pain, prostration and vomiting. External injury.—None. Stomach: size and site of rupture.—Two-inch rent at pylorus extending into the duodenum. Stomach at autopsy.—Rent easily extended, tissues fragile. Internal injuries.— None. Procedure and result.—Died, eighteen hours.

FARRELL: Lancet, vol. i, p. 1243, 1894. Male, aged thirteen. Schoolboy. Nature of

trauma.—At play with sled after school (had eaten). Symptoms.—Headache, cold feeling, vomited food, convulsions. External injury.—None. Stomach: size and site of rupture.—Three-inch rent on posterior wall. Stomach at autopsy.—Area of inflammation and degeneration of muscle about rent. Rest of stomach healthy. Internal injuries.—None. Procedure and result.—Died, twenty-two hours.

VERSÉ: Munch. Med. Wochnschr. Nr. 46, p. 1290, 1918. Female, aged ten. Imbecile. Nature of trauma.—Slipped and fell on steps; later ate bread, milk, mush. Symptoms.—Abdominal pain, vomited, subcutaneous emphysema (yeast in stomach contents grew 3 mos). External injury.—None. Stomach: size and site of rupture.—Two by two and one-half cm. at fundus, posterior wall. Other tears of serosa. Stomach at autopsy.—Mucosa red. Rent in large red area where serosa is stripped from muscle. Internal injuries.—None. Procedure and result.—Died, eight hours.

GLASSMAN: 1928. Male, aged six. Schoolboy. Nature of trauma.—Stumbled and fell to the sidewalk. Symptoms.—Shock, distention, dulness in flanks, obliterated liver dulness. External injury.—Cut of forehead. Stomach: size and site of rupture.—Three and one-half-inch rent on greater curvature of body and three-quarters-inch rent greater curvature, cardia. Stomach at autopsy.—Diffuse extravasations of blood in submucosa. Internal injuries.—None. Procedure and result.—Operated. Died, six hours.

TABLE IV.

*Spontaneous Rupture.*

CARSON, J.: Edinb. Med. and Surg. Jour., vol. lxvi, pp. 25–31, 1846. Male, aged twenty. Inciting cause.—Hearty meal. Symptoms.—Mild shock, abdominal pain, tenderness, rigidity, nausea. Stomach: size and site of rupture.—Two and one-half-inch rent in greater curvature. Three inches from œsophagus. Condition stomach post mortem.—Greatly distended. Mucosa of greater curvature injected. Procedure and result.—Died, fifteen hours.

LANTSCHNER: Wiener Med. Blätter, Nr. 4–5, V. J. 81, 1881. Female, aged seventy-two. Inciting cause.—Eight cups water, two cups tea and cold meat. Symptoms.—Sudden "explosion" preceded by nausea and vomiting. Stomach: size and site of rupture.—Four-inch rent on posterior wall, running transversely. Condition stomach post mortem.—Stomach in large umbilical hernia. Procedure and result.—Died, thirteen hours.

CHIARI: Wiener Med. Blatter Nr. 3 d. Aertze Wein, 1881. Female, aged fifty-three. Inciting cause.—Gaseous distention. Symptoms.—Symptom of perforation and subcutaneous emphysema. Stomach: size and site of rupture.—Four-inch rent, middle of lesser curvature through scar of previous ulcer. Condition stomach post mortem.—Markedly distended. Old scar but no sign of ulcer present. Procedure and result.—Died.

HOFFMAN: Virchows Jahresbericht, 1881. Male, aged twenty-four. Inciting cause.—Acute dilatation of the stomach. Symptoms.—Not given. Stomach: size and site of rupture.—Three-inch rent, knife-like, on lesser curvature. Condition stomach post mortem.—Enormously dilated stomach with thickened walls.

MEYER-LEUBE: Zbl. f. klin. Med., p. 81., 1886. Male, aged thirty-seven. Inciting cause.—Much rye bread and young beer full of yeast. Symptoms.—Distention, cyanosis, disappearance liver dulness. Subcutaneous emphysema. Stomach: size and site of rupture.—Four-inch rent in fundus. Condition stomach post mortem.—Mucosa of cardia emphysematous and hæmorrhagic (black) in spots. Procedure and result.—Died, two and one-half hours.

VERSÉ: Munch. Med. Wochenshr. Nr. 46, 1918. Female, aged thirty-two. Inciting cause.—Large meal of cake after diarrhœa for few days. Symptoms.—Pain in epigastrium and cyanosis but no dyspnœa. Stomach: size and site of rupture.—Small rent in centre of necrotic area on anterior surface. Many erosions mucosa. Condition stomach post

mortem.—Stomach dilated to within four inches of symphysis. Procedure and result.—Operation revealed beginning peritonitis. Died, twenty-four hours.

DAXENBERGER: M. m. W., p. 313, 1906. Male, aged twenty-five. Inciting cause.—Acute dilatation of the stomach. Symptoms.—Not noted. Stomach: size and site of rupture.—Rent in fundus. Condition stomach post mortem.—Stomach dilated, in hernia, and has scar at pylorus. Procedure and result.—Died, sixteen hours.

MESNARD: * Female, aged twenty-nine. Inciting cause.—Hearty meal of kraut and fresh pork. Symptoms.—Pain, nausea. Feeling of something give way. Collapse. Stomach: size and site of rupture.—Rents of serosa on lesser curvature. Few mucosa tears of fundus. Condition stomach post mortem.—Not stated. Procedure and result.—Died, nine hours.

NEWMAN, A. J.: * 1868. Male, aged thirty. Inciting cause.—Distention following a meal. Symptoms.—Vomiting, collapse, tympany and subcutaneous emphysema. Stomach: size and site of rupture.—One-half-inch rent about three inches from cardia. Condition stomach post mortem.—Mucosa dark red and walls thin. Procedure and result.—Died, fourteen hours.

STEINMAN: Zbl. f. Chir. S. 181, 1917. Female, aged seventeen. Inciting cause.—Ate large portion of sauer kraut. Symptoms.—Distention, nausea, vomiting. Felt rupture, pain and no more vomiting. Stomach: size and site of rupture.—Three-inch rent on posterior wall running transversely. Condition stomach.—Stomach distended. Edges of wound did not appear pathological. Procedure and result.—Operation. Recovery.

BUSCH: Frankfurt Zeitscht. f. Path., p. 30, 1924. Female, aged forty-seven. Inciting cause.—Three dumplings, two pounds plums, one pound grapes. Symptoms.—Pain, nausea, distention, subcutaneous emphysema. Stomach: size and site of rupture.—One cm. rent, lesser curvature anterior wall. Mucosa tears, anterior wall, lesser curvature. Condition stomach post mortem.—Stomach dilated and areas of hematomata about the rents. Procedure and results.—Died, three and one-half hours.

MURDFIELD: Klin. Wochnscht. (Ab. J.A.M.A. Nov. 13, 1926). Male, aged thirty-nine. Inciting cause.—After much beer and other fluid took little bicarbonate. Symptoms.—Excruciating pain immediately afterward. Stomach: size and site of rupture.—Rent in lesser curvature nearer to cardia. Condition stomach post mortem.—Apparently normal on histological study. Procedure and result.—Died.

KUNDRAT: † 1880. Female, child. Inciting cause.—Hearty meal. Symptoms.—Suddenly seized with abdominal pain. Stomach: size and site of rupture.—Two and one-half-inch rent in fundus, with pulpy appearance. Condition stomach post mortem.—Rent appeared pulpy and surrounded by softening. Procedure and result.—Died in a few hours.

FROBOESE: Med. Klinik, May, p. 494, 1918. Female, aged nineteen. Inciting cause.—Acute distention. Symptoms.—Abdominal pain, tenderness, distention. Two days without food. Stomach: size and site of rupture.—Eight cm. rent in anterior wall near greater curvature. Condition stomach post mortem.—Markedly dilated, with softening and thin walls. No peritonitis. Contained food. Procedure and result.—Died in short time. Autopsy, fifteen hours P.M.

## CONCLUSIONS

1. Rupture of the healthy stomach is uncommon. It may be spontaneous or due to severe, moderate or slight trauma.

2. With diffuse (severe and moderate) trauma, other organs are often involved, most often the spleen and liver. External signs of injury are usually not present but occur more often in the localized type of injury. Vomiting is a prominent symptom and hæmatemesis occurs in about 50 per

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* Busch, M.: Frankf. Zeitschr. f. Path. 30:30, 1924.

† Hauser, G.: Handb. Path. Anat. u. Hist. Henke u. Lubarsch, iv: 667, 1926.

cent. of the cases. The site of rupture is most often at or near the pylorus.

3. With rupture due to simple or slight trauma there is nearly always a distended stomach which has evidence of disease only in a very small percentage of cases.

4. Spontaneous rupture and that due to slight trauma are closely related as far as their mechanism and the site of rupture are concerned. The underlying causative factors are either purely mechanical (due to distention alone) or combined with acute local changes which constitute an area of least resistance.

5. If rupture of stomach is suspected, laparotomy should be performed early. (X-ray is a valuable aid to diagnosis.) If a rent in the stomach is found at operation, the stomach should be examined for other tears and both liver and spleen should be explored for possible rupture.

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# RUPTURED GASTRODUODENAL ULCER

## A REPORT OF TWENTY-SEVEN CASES

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THE importance of an early and correct diagnosis in ruptured gastro-duodenal ulcer has been repeatedly called attention to, in view of the favorable outcome, if treatment is instituted without delay. Because of the acuteness of the condition, the avenues for a correct diagnosis are restricted. At the time of the sudden catastrophe and shortly after, the patients are so sick as to render a comprehensive and intelligent history most difficult. The usual history is that of sudden onset when the stomach is full, with severe, excruciating, tearing pain in the upper abdomen, accompanied by vomiting. There are evidences of shock. Often there is early and partial recovery and the general phenomena associated with the acute catastrophe soon subside, and the signs and symptoms are in the large number of instances localized to the epigastric area.

As a means of early diagnosis, Vaughan and Brams[1] refer to the early recognition of acute perforation by X-ray of spontaneous pneumoperitoneum. In thirteen of their fifteen cases, it was easily and distinctly demonstrated. The free gas has been seen as early as two hours after acute perforation. A small quantity is sufficient for its demonstration. The presence of free air is shown by a distinctly bright zone which shifts on change of posture. The most typical picture is when the patient is upright. The air bubble then assumes a very distinct sickle shape, and disappears on change of posture. It is not necessary, however, to place the patient upright, as a sufficiently characteristic picture may be obtained by placing the patient on his left side, and observing the air bubble between the external abdominal wall and the lateral surface of the liver. The entire procedure may be performed with the screen and with the patient still on the stretcher.

That the air is free may be easily demonstrated by changing the posture when the bubble seeks the uppermost portion of the cavity. The sign is of great value because it makes possible an early and definite diagnosis without danger or discomfort. The examination is easily performed and requires no preliminary preparation.

Recently Vigyzao[2] mentioned the presence of a subcutaneous emphysema as diagnostic of ruptured ulcer. The emphysema is usually localized to the umbilical and cæcal regions. The finding has been corroborated by J. Podlaha,[3] who also reports emphysema of the left supra-clavicular fossa.

In regard to the obliteration of the liver dulness either partially or completely, it is important to point out that too much reliance should not be placed on this sign. A positive finding is of great help, but a negative finding that is the failure of obliteration of liver dulness does not exclude the presence of a perforation. The size of the perforation, the presence or absence of food in the stomach at the time of rupture, the degree of inflammatory reaction around a chronic penetrating ulcer which has perforated will all influence the absence or presence of sufficient air to obliterate any liver dulness.

In perforation of an ulcer at the pylorus or in the duodenum, a plastic exudate may form between the site of perforation and the nearby structures (gall-bladder, liver, omentum, colon), and thus prevent the escape of any air. Our own experience is that this sign (*i.e.* obliteration of liver dulness) is neither early nor helpful. To wait for this finding would be extremely dangerous, for the time element in ruptured ulcer is of the greatest importance. As has been shown repeatedly and as borne out by our experience, the earlier the operation, the greater the possibility for recovery.

The differential diagnosis of ruptured gastroduodenal ulcer, at times, presents difficulties. If the patient has been under medical care for an ulcer, the diagnosis of which has been definitely established, the occurrence of an acute abdominal catastrophe will be readily ascribed to a perforation of the ulcer. However, the onset of severe abdominal pain in adults who have no previous gastric symptoms, does not preclude the probability of a ruptured ulcer as evidenced by certain cases in our report. Nevertheless, a consideration of other conditions which may be responsible for the clinical picture is essential. The classical picture of ruptured ulcer upon physical examination is simulated by very few conditions.

In the consideration of the differential diagnosis, the following conditions present themselves:

1. Gall-bladder disease. (Calculous and non-calculous.) The symptoms of an acute attack are usually preceded by a history of chronic gall-bladder disease. Fever is usually present and jaundice may or may not be an early sign. There is localized tenderness in the right upper quadrant with a distention of the gall-bladder which may be palpable, the liver is enlarged, and there is usually a definite Head zone over this area. The tenderness and rigidity are more localized and if not over the gall-bladder area, is nearby and not diffuse. There is generally an increased amount of bilirubin in the blood (van den Bergh reaction). A history of previous attacks with relief induced by hypodermic injections of morphine sulphate favors the diagnosis of gall-bladder disease. Rupture of the gall-bladder is a rare occurrence and occurs after a lapse of several days following the acute symptoms.

2. Acute pancreatitis quite frequently presents the subjective complaints that closely resemble ruptured ulcer. The excruciating abdominal pain may start in the mid-epigastrium and is bursting or tearing in character. There is frequently a past history of gall-bladder disease. The pain may radiate to both sides but particularly to the left flank or back. Many of the patients are

in complete collapse, cyanotic and present a distinct Malar flush soon after the onset. The abdomen is distended, partly due to fluid and partly due to the distention of the paralyzed ileum as a result of the severe splanchnic shock. Occasionally the impression of a wide bar-like mass may be noted in the epigastrium.

3. Acute perforated appendicitis may produce local and reflex phenomena which may resemble ruptured ulcer. Occasionally, if in an undescended cæcum, an appendix situated rather high up becomes acutely inflamed, and goes rapidly on to gangrene and perforation; there may be a clinical history and findings which closely resemble that of perforated ulcer. Recently one of us, Dr. W. L. W., operated upon a patient in whom an acute inflammation of the appendix had gone on to gangrene and perforated at the cæcal-appendicular margin. There had been a free escape of colon contents, producing a widespread peritonitis with intense peritoneal reaction, marked rigidity of the abdominal muscles and shock.

It is important to realize that in many of the patients with ruptured gastroduodenal ulcer there is definite and marked tenderness in the right lower abdomen. There is a tendency for the contents to gravitate to the right lower abdomen, if rupture occurs when the stomach is full. Early operation should be advised, in a suspicious case, because of the great danger accompanying delay.

4. Intestinal obstruction when situated high up in the small intestine, and if sudden in onset, will produce acute pain. Generally there is severe shock and the persistence of agonizing pain that comes with ruptured ulcer. The vomiting associated with obstruction is persistent at first, bilious and later fecal; the cramps may be rhythmical at definite intervals, and at times one may feel a distended loop. The abdomen is slightly distended rather than scaphoid, and rigidity is not so marked.

5. Diaphragmatic pleurisy may set in with such acute and severe symptoms that the differential diagnosis may present the greatest of difficulties. The board-like rigidity of the abdominal muscles, the pain, and the entire clinical picture taxes the medical ingenuity. If the history of a respiratory infection is obtained, if abdominal reflexes are present, if it is possible to have the patient relax, the abdomen may be then palpated, and if found soft, the probability of a diaphragmatic pleurisy would be more definite.

6. Renal colic is frequently associated with viscero-visceral, viscero-sensory and viscero-motor phenomena. The abdominal rigidity and tenderness are usually associated with some degree of distention. The individual with an attack of renal colic is apt to throw himself restlessly around, whereas in ruptured ulcer, despite the excruciating pain, the individual generally remains quiet. The presence of red blood cells in the urine, the tenderness in the flank, positive Murphy sign and intervals of relief generally indicate renal calculous. In ruptured ulcer there may be slight relief several hours after the acute onset, when the reactionary fluid bathes the entire affected area. In view of the importance of the time element in ruptured ulcer, morphine

should not be given until the diagnosis is established, because of the danger of masking the symptoms and signs.

7. Coronary artery thromboses may closely simulate perforated ulcer. Details are furnished by L. L. Hart[4] of a case where coronary thromboses simulated perforated ulcer. For the past fifteen years, Hart's patient had frequent spells of a hunger sensation in the epigastrium, coming on at about ten A.M., and relieved by a little lunch. A severe attack with rigidity of the abdomen, leucocytoses and elevation of temperature seemed to corroborate the tentative diagnosis of ulcer. Death in twelve days. Necropsy showed no ulcer, but old thromboses of right coronary.

## GROUP OF TYPICAL ILLUSTRATIVE CASES

This group of thirteen patients presented a history of gastric symptoms characterized by chronicity and periodicity from one to twelve years.

The ages ranged from twenty-six to fifty-eight years, and the average was forty-two years. Four patients had rupture of a gastric ulcer. In each instance the ulcer was situated on the lesser curvature of the stomach in the region of the pylorus. In nine patients the ulcer was situated on the anterior or superior and lateral surface of the first portion of the duodenum. Four of these thirteen patients had radiographic examinations which confirmed the diagnosis of ulcer prior to the rupture. All gave a history of acute onset with terrific pain localized to the epigastrium. In about one-half the number, there had been a history of greater discomfort than usual after meals, three to seven days before the rupture. In most of these cases the rupture took place while the stomach was full, immediately or one to two hours following a meal.

One patient who had been in the habit of lavaging his stomach had the perforation occur during this process. Another individual with a stenosing duodenal ulcer, perforated a few hours after barium meal.

## RUPTURED GASTRODUODENAL ULCER

### TYPICAL CASES—ISRAEL ZION HOSPITAL

CASE I.—N. S., age fifty-three, male; admitted August 11, 1925; discharged August 29, 1925; result, recovery; complications, none; occupation, laborer; history, gastrointestinal symptoms for years; onset, twenty-four hours gradual, three hours before admission acute; X-ray, none; operation, one inch from pylorus on stomach side, perforation left anterior.

CASE II.—S. V., age fifty-one, male; admitted February 29, 1925; discharged January 18, 1926; result, recovery; complications, none; occupation, worker; history, five years ago diagnosed as symptoms of ulcer, no trouble until now; onset, one hour before admission severe pain in abdomen; X-ray, none; operation, perforating gastric ulcer near pylorus.

CASE III.—H. N., age forty, male; admitted February 18, 1926; discharged April 7, 1926; result, recovery; complications, lung abscess left pleural effusion, pneumothorax; occupation, operator; history, eight years' recurrent gastric symptoms; onset, supper at

eleven P.M., awakened one A.M. from sleep; X-ray, positive for gastric ulcer; operation, perforating gastric ulcer lesser curvature.

CASE IV.—A. K., age thirty-nine, male; admitted May 12, 1926; discharged June 1, 1926; result, recovery; complications, pneumonia left base; occupation, laborer; history, five years' complaints; onset, two hours before admission acute, severe upper abdominal pain; X-ray, positive for duodenal ulcer; operation, first portion duodenum, small perforation.

CASE V.—O. N., age fifty-eight, male; admitted December 26, 1926; discharged, December 27, 1926; result, died; complication, none; occupation, laborer; history, two years' repeated gastric symptoms; onset, abdominal cramps for one week, ten hours before admission severe cramps below umbilicus; X-ray, none; operation, perforating ulcer first portion duodenum; remarks, week of symptoms of penetrating, perforating ulcer.

CASE VI.—L. F., male; admitted October 27, 1925; result, recovery; complications, pneumonia left lung, abscess (bronchoscopic treatment); history, three years' gastric symptoms; onset, three days before admission severe cramp, admitted to a hospital, left against advice, another severe attack few hours before admission to Israel Zion; X-ray, none; operation, callous ulcer one and one-quarter inches long, second portion of duodenum anterior surface.

CASE VII.—S. Z., age thirty-two, male; admitted August 8, 1927; discharged August 24, 1927; result, recovery; complications, none; occupation, laborer; history, attack 1918, well up to two weeks ago, acute upper abdominal pain three hours before admission, vomiting; onset, sudden; X-ray, none; operation, ruptured ulcer first portion duodenum.

### TYPICAL CASES—JEWISH HOSPITAL

CASE I.—R. P., age forty-two, male; admitted November 25, 1920; discharged December 7, 1920; result, recovery; complications, none; occupation, laborer; history, five years' gastric symptoms, pain one to two hours after food; onset, lavaged stomach, had knife-like pains; operation, perforating pyloric ulcer.

CASE II.—F. G., age forty-four, male; admitted March 23, 1921; discharged April 9, 1921; result, recovery; complications, none; occupation, clerk; history, four years' periodicity and chronicity of gastric symptoms one to two hours after food; onset, thirty minutes after every meal; operation, two hours after onset, perforation of ulcer first portion of duodenum; remarks, twenty-five years ago had chancre.

CASE III.—J. A., age twenty-six, male; admitted October 9, 1924; discharged December 5, 1924; result, recovery; complications, pelvic abscess; occupation, laborer; history, gastric symptoms for ten months; onset, six hours before operation, sudden, as if ton of bricks fell on him; operation, perforating anterior surface, first portion duodenum; remarks, second operation for pelvic abscess.

CASE IV.—W. W., age forty-one, male; admitted July 23, 1925; discharged August 7, 1925; result, recovery; complications, none; occupation, laborer; history, periodic and chronic gastric symptoms for ten years; onset, twelve hours after X-ray series sudden pain; X-ray, none; operation, perforating anterior wall, first portion duodenum.

CASE V.—J. B., age fifty, male; admitted March 9, 1926; discharged March 25, 1926; result, recovery; complications, none; occupation, tailor; history, five years' gastric symptoms five to ten minutes after food, pain disappeared spontaneously; onset, three hours before admission pain right lower quadrant; X-ray, positive duodenal ulcer; operation, perforating first portion duodenum with induration.

CASE VI.—I. S., age thirty-three, male; admitted January 26, 1927; discharged February 8, 1927; result, recovery; complications, none; occupation, laborer; history, three years' recurrent pain, two to three hours after food; onset, one to one and one-half hours before admission sudden intense upper abdominal pain; X-ray, none; operation, perforating first portion duodenum; remarks, two weeks prior to rupture, constant pain.

# RUPTURED GASTRODUODENAL ULCER

## ATYPICAL GROUP

Included in this group of fourteen patients are those without previous history of gastric disturbance.

The history and the onset of acute symptoms and physical findings did not conform with the history and usual findings present in ruptured ulcer. It was interesting to note that in all of these patients as well as in the preceding group, the occupation, with one or two exceptions, was that of a laborer or mechanical operator. The ages varied from twenty to sixty-two years, the average being thirty-seven. All fourteen patients were males and there was but one death in the series. This death was due to an accidental surgical complication. Four of the patients had a perforation of a gastric ulcer situated two or three inches from the pylorus and the remaining ten had a perforated ulcer in the first portion of the duodenum.

The physical appearance of the ulcer in all of the cases with one exception showed evidences of chronic inflammation. In that one instance there was a small perforation in the region of the pylorus with no evidence to suggest a chronic ulcer. The possibility of an acute ulcer going rapidly on from the stage of early mucosal defect to perforation was considered. This patient, a physician, thirty-one years of age, had been perfectly well up to three weeks prior to perforation. A recent radiographic examination of the stomach and duodenum (prior to rupture) had failed to disclose an ulcer defect.

### ATYPICAL CASES—ISRAEL ZION HOSPITAL

CASE I.—H. L., age twenty-four; admitted December 17, 1925; discharged December 30, 1925; result, recovery; complications, none; occupation, laborer; history, eighteen hours before operation cramp in right lower quadrant (two A.M.), nausea, constipated; castor oil, followed by vomiting; apparently comfortable, pain only on palpation; operated for acute appendicitis; operation, ruptured ulcer, first portion duodenum.

CASE II.—E. G., age thirty-one; admitted January 28, 1927; discharged, February 10, 1927; result, recovery; complications, none; occupation, physician; history, three weeks before operation belching and epigastric distress after food, evening before operation sudden epigastric pain; operation, ruptured gastric ulcer near pylorus, small perforation; remarks, acute ulcer.

CASE III.—M. E., age thirty; admitted January 29, 1927; discharged February 11, 1927; result, recovery; complications, none; occupation, clerk; history, never ill, sudden acute agonizing epigastric pain after food; vomiting; operation, perforated ulcer first portion duodenum.

CASE IV.—H. F., age sixty-two; admitted May 26, 1927; died; complications, drain loosened, fistula: died seventh day post-operative; occupation, worker; history, well up to four days before onset; for four days distress after food especially, constant pain; operation, perforating anterior wall first duodenum.

CASE V.—F. P., age fifty-five; admitted August 26, 1927; discharged September 12, 1927; result, recovery; complications, none; history, intermittent epigastric pain two to three days, ten hours before admitted intense agonizing epigastric pain; operation, post surface first portion duodenum near pylorus; remarks, obliterated left diaphragm.

CASE VI.—H. S., age forty; admitted October 25, 1927; discharged November 6, 1927; result, recovery; complications, none; history, two A.M., severe epigastric pain, vomiting (two weeks occasional distress two hours after food); operation, perforating ulcer anterior wall first portion of duodenum.

CASE VII.—R. I., age twenty-six; admitted November 18, 1927; discharged December 2, 1927; result, recovery; complications, none; history, three months ago had first symptoms of distress two to three hours after food. Bicarbonate and food relieved pain, one and one-half hours before being admitted excruciating pain, collapse; operation, perforated ulcer anterior wall first duodenum induration.

CASE VIII.—M. S., age twenty; admitted December 24, 1927; discharged, January 14, 1928; result, recovery; complications, none; history, two days ago heartburn and eructations with epigastric pain, day of admission collapsed with epigastric pain, vomiting several times; operation, mid-gastric region, anterior surface, perforating large gastric ulcer, chronic appendix ,with fecoliths removed at same time; remarks, age, no symptoms.

CASE IX.—C. M., age seventy; admitted May 3, 1928; discharged May 20, 1928; result, recovery; complications, none; occupation, housewife; history, about three years ago began to complain of nausea, cramp-like pains of few minutes' duration located in epigastrium, no relation to meals, frequent hunger pains, vomit occasionally, for past few months apparently normal, suddenly seized with severe pain in right abdomen, vomited once, particles of undigested food, no blood, obliteration of left duodenum; operation, perforated duodenal ulcer.

ATYPICAL CASES—JEWISH HOSPITAL

CASE I.—I. F., age thirty-two, male; admitted May 10, 1920; discharged June 3, 1920; result, recovery; complications, none; occupation, clerk; history, no symptoms until three days ago. Pain gradually worse; operation, perforated pyloric ulcer.

CASE II.—I. F., age thirty-eight, male; admitted April 22, 1924; discharged May 9, 1924; result, recovery; complications, none; occupation, driver; history, ten hours before admitted while at work sudden epigastric pain, no obliteration of left duodenum; operation, perforated ulcer first portion duodenum, superior anterior surface.

CASE III.—A. B., age forty-four, male; admitted March 30, 1925; discharged April 13, 1925; result, recovery; complications, none; occupation, bricklayer; history, twelve hours before admitted mild epigastric pain, gradually worse, more severe six hours before admitted; operation, perforating gastric ulcer near pylorus, anterior surface.

CASE IV.—W. S., age twenty-nine, male; admitted July 12, 1925; discharged August 7, 1925; result, recovery; complications, broncho-pneumonia; occupation, laborer; history, thirteen hours before admitted mild abdominal pain, four hours before went to toilet, strained, sudden epigastric pain; operation, perforated ulcer first duodenum.

CASE V.—N. S., age thirty-two, male; admitted March 13, 1925; discharged March 28, 1925; result, recovery; complications, none; occupation, stationery store; history, for five weeks epigastric pain after food, two hours before admitted excruciating pain in lower abdomen; operation, perforated ulcer first portion duodenum.

CASE VI.—C. S., age forty-four, male; admitted March 30, 1926; discharged April 13, 1926; result, recovery; complications, none; occupation, laborer; history, four hours before admitted on arising from bed had sudden excruciating pain in right upper abdomen; operation, perforated ulcer first portion duodenum.

COMMENT

1. Perforation may occur in young as well as old people. Its greatest frequency, however, is in middle-age, during the period of greatest physical activity.

2. Almost half of the patients in our series presented either symptoms or physical findings which did not conform with the usual and accepted signs and symptoms present in such a calamity.

3. In this series two patients out of twenty-seven died; one death followed an accidental surgical complication, and the other was due to general lowered resistance and an extensive peritonitis, because of delay in reaching the hospital. As has been so frequently stressed in previous communications, any patient should be operated upon immediately after rupture, and recovery generally follows.

4. Inspection of the site of perforation revealed evidences of chronic inflammation in all of the patients with one exception. Absence of evidence of chronic inflammation, the small size of the perforation, and the softness of the tissue appeared to point to an acute ulcer which had rapidly gone on to rupture.

5. The differential diagnosis may present many problems, particularly in view of the difference in the reactions individuals have normally to pain sensations. In any suspected case, hospitalization should be demanded.

## ADDENDUM

Since this report has been forwarded for publication there has been added a report of one more patient.

This record, Case IX, in the Atypical Group, presents a history of ruptured duodenal ulcer, with recovery, in a woman seventy years old, who had seldom complained in her past life.

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# MYOMA OF THE APPENDIX*

## By Amos R. Koontz, M.D.

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Although there is much more striated muscle in the human body ·than smooth muscle, tumors of striated muscle are much rarer than tumors of

TABLE I

| Case No. | Author | Date | Sex | Age | How Found | Clinical Note | Nature of Tumor |
|---|---|---|---|---|---|---|---|
| 1 | Lafforgue[5] | 1893 | ♀ | 52 | not mentioned | none given | Three small submucous fibromyomata, one pedunculated. |
| 2 | Rosi[6] | 1897 | ♂ | 56 | operation | Pain in inguinal region and diarrhea for twenty years. | Myoma 9.6 cm. in diameter in inguinal hernia sac. |
| 3 | Steiner[2] | 1898 | ♀ | 20 | autopsy | Found at autopsy following death from brain tumor. No appendix symptoms. | Fibromyoma, 3 x 2½ cm., at base of appendix. |
| 4 | Kelley[8] | 1900 | ♀ | not given | operation | Appendix removed with uterus which contained fibromyomata. | Two fibromyomata of appendix, each 5 mm. in diam., and one having calcareous deposits. |
| 5 | Kelley[8] | 1900 | not given | not given | not mentioned | none given | Single fibromyomatous nodule. |
| 6 | Hayem[9] | | | | | | Fibromyoma of appendix. |
| 7 | Corner[10] | 1909 | ♂ | 23 | operation | History of two attacks of acute appendicitis. Interim removal. | Small rounded submucous fibromyoma of distal end. |
| 8 | Stickney[11] | 1915 | ♀ | 39 | operation | Symptoms of chronic appendicitis for one year. | Clubbed appendix tip containing five small myomata, the largest 3.5 mm. in diam. |
| 9 | Redway[12] | 1917 | ♀ | 36 | operation | Pain in right lower quadrant of five months' duration. | Fibromyoma of distal end, small. |
| 10 | Redway[12] | 1917 | ♀ | 40 | operation | Uterus, tubes, one ovary and appendix removed for general pelvic inflammation. | Fibromyoma of distal end, small multiple fibromas of uterus also. |
| 11 | Podesta and Pividal[13] | 1923 | ♀ | Child-bearing-Age | operation | Attacks simulating appendicitis. | Fibromyoma—external—size of hazelnut. |
| 12 | Leorat[14] | 1924 | ♂ | 39 | operation | Acute appendicitis with perforation at base. | Fibromyoma size of cherry at tip of appendix. |
| 13 | Lillie and Parcher[15] | 1927 | ♂ | 40 | operation | Abdominal pain and distress for 6 or 7 yrs. Operation revealed adhesions about gall-bladder, pylorus and appendix. | Three submucous myomata, each 5 mm. in diameter. |
| 14 | Koontz | 1928 | ♀ | 26 | operation | Symptoms simulating chronic appendicitis. | Diffuse fibromyoma of tip of appendix. |

* Read before the Medical and Chirurgical Faculty of Maryland, April 25, 1928.

smooth muscle. Myomata of striated muscle (rhabdomyomata) are indeed rare occurrences, while among myomata of smooth muscle (leiomyomata) are to be found what Adami[1] calls the commonest of all tumors—the fibro-myomata of the uterus. The next most common site of the leiomyoma is, according to Adami,[1] the non-striated coats of the gastro-intestinal tract. However, the digestive tract as a site for the development of myomata is a very poor second to the uterus. Steiner,[2] who wrote an exhaustive paper on the subject in 1898, was able to collect only fifty-one cases.

Considering the small number of myomata found in the entire gastro-intestinal tract, the appendix probably comes in for more than its proper proportionate share. This share, however, is not large. Kelly,[3] in 1909, stated that there were only three cases of myoma of the appendix recorded. Dandy,[4] in 1914, could find in the literature only ten cases of benign tumors of the appendix of all sorts, and the case he reported—that of a myxoma of the appendix from Halsted's clinic—was the first case of benign tumor of the appendix among the several thousand specimens in Doctor Bloodgood's pathological section of the surgical clinic of the Johns Hopkins Hospital. The number of reported cases of myoma of the appendix has now increased to thirteen. A brief summary



FIG. 1.—Gross appearance of specimen showing large bulbous tip of the appendix.

of these cases is shown in Table I. I wish to add another case to those already reported.

CASE I.—K. B., an unmarried white female, aged twenty-six, had been troubled with pain in the epigastrium, right upper abdominal quadrant and umbilical region for a period of three months. There was associated constipation. The pain was cramp-like in character and gradually became localized at McBurney's point.

Abdominal examination was negative except for considerable tenderness at McBurney's point. The leucocyte count was normal.

Appendectomy was performed through a right rectus incision November 23, 1921. The pelvic organs and abdominal organs other than the appendix were normal. The appendix was bound down behind the cæcum, the proximal part atrophic, the distal end enlarged and bulbous (Fig. 1). On opening the appendix the lumen of the proximal portion was found to be obliterated, while the wall of the distal portion was very thick and fibrous, suggesting a long period of chronic inflammation. Micro-scopic sections (Fig. 2) showed that we were dealing with a fibromyoma.

The patient was seen on March 30, 1928, and stated that there had never been any recurrence of her symptoms. She is now married and has two children.

18                                                                  273

A study of the reported cases of myoma of the appendix shows that about half of them presented symptoms suggestive of appendicitis, and were operated upon because of these symptoms. The rest were accidental findings at operations for other conditions, or at autopsy. Most of the tumors were small, but the sizes ranged from tumors a few millimeters in diameter to one 9 6 cm. in diameter. This unusually large one (Rosi) was found in an inguinal hernia sac, and its nature was not suspected until herniotomy was performed. In none of the other reported cases could the tumor have been palpated through the abdominal wall. In no case was the diagnosis made before operation or autopsy.
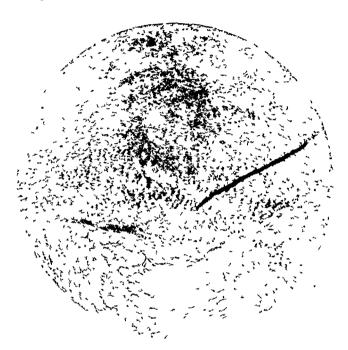


Fig 2 —Microscopic section of tumor.

Eight of the cases occurred in women, four in men, and in two the sex was not mentioned. The youngest case was twenty years of age and the oldest fifty-six.

In only three of the cases (Rosi, Stickney, Lillie and Parcher) were the tumors pure myomata. All the rest were fibromyomata. Ewing[16] states that "according to Boettcher and Lode three types of intestinal myomas may be distinguished: (1) Small multiple nodular or polypoid tumors arise from local proliferations in the muscularis, the mucosa is free, (2) broad thick tumor masses form in the muscle layers, while the mucosa becomes adherent to the tumor; (3) large polypoid subserous myomas may project into the peritoneum." The same classification, with certain modifications, holds, as would be expected, for the reported cases of myoma of the appendix. The author's case was of the broad diffuse type originating from all the muscle layers, which Boettcher[17] calls a composite myoma.

The interesting group of endometrial implantation "adenomyomata" of the appendix have not been included in this report as they are not primary tumors of the appendix, and are not true myomata. Dougal,[18] Suzuki,[19] and Seelig[20] have recently reported cases of these implantations Seelig states that his case is the sixth recorded case. Sampson[21] in 1921 showed that implantation "adenomyomata" develop as a result of the rupture of chocolate cysts of the ovary, which are lined by endometrial tissue; and in 1922[22]

he put forward the hypothesis that the endometrium gets into the ovaries by escaping from the fimbriated ends of the fallopian tubes, due to an abnormal menstruation with a back flow.

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# PRIMARY CARCINOMA OF THE VERMIFORM APPENDIX

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A REVIEW of the literature to find the first report of an authentic case of carcinoma of the appendix has produced some very interesting results. Not a few authors have written about this supposedly rare condition. Invariably, with one exception, Merling, *Journal de l'Experience*, 1838, is given credit for the original case report—or at least for the first reference to carcinoma of the appendix.

There was created, therefore, the desire to see and perhaps extract Merling's report. No difficulty was experienced in locating at the New York Academy of Medicine the *Journal de l'Experience*, 1838. An accurate translation, however, failed to mention any reference whatever to carcinoma. To prevent the possibility of an error, the article was read aloud to me. At no time is the word carcinoma used. Merling discusses the anatomy of the appendix and a variety of diseases affecting it. To quote from the article: "At an autopsy the walls of the vermiform appendix were gray brown, scirrhous, as if formed by small hard tumors. Near the cæcum the appendix presented a round opening the size of a pea with hard and unequal edges." This description hardly warrants the diagnosis of carcinoma. Yet it is the only point of Merling's thesis that even mentions the word tumor. It is reasonable, therefore, to conclude that he did not report the first case of carcinoma of the appendix.

According to the literature, Crouzet[5] reported the second case of carcinoma of the appendix. This was in 1865, twenty-seven years after Merling's report. What he really reported was a soft, sessile, hæmorrhagic tumor of undetermined etiology. There is no reason to suspect or to think that he was describing a case of carcinoma of the appendix.

The following year, 1866, Rokitansky[22] reported four cases of carcinoma of the appendix. The description of the cases, together with the lack of pathological evidence, does not warrant such a diagnosis.

Kolaczeks[10] in 1875 described unquestionably a case of carcinoma, but it involved the cæcum, not the appendix. Leichenstein in 1876 and Bierhoff in 1880 both described cancer of the appendix. Unfortunately, however, these are not admissible for they were secondary cases and not primary in the appendix.

It was not until 1882 that Beger[2] described and reported the first unquestionable case of primary carcinoma of the appendix. He does not claim that his is the first case. He does state that "carcinoma of the appendix

is rare." No doubt he had in mind the cases of supposed similarity previously reported.

The importance of carcinoma of the appendix was first emphasized in 1903, exactly twenty-one years after the first authentic report by Beger. In that year, Elting [7] and Moschkowitz [15] each published in the ANNALS OF SURGERY articles describing this condition and reporting, after careful search of the literature, only forty in the case of the former and eighteen in the case of the latter. In 1906, twenty-four years after the original description, only forty-two cases had been reported. Twenty-eight of these were by American authors.

As time rolled on patients accumulated more money, hospitals became better endowed, and pathological service was better grounded. This resulted in the examination of more of the specimens removed at operation. Finally most specimens removed were examined, and this resulted in the discovery of many cases of cancer of the appendix. In the light of subsequent events, largely brought about by the routine examination of all specimens removed at operation, carcinoma of the appendix has been re-discovered many times. The condition, therefore, is no longer a rarity.

Sporadic cases have been not infrequently reported, and from time to time the literature has been brought up to date. The most recent treatise, that by Van Alstine,[25] reports two additional cases and collects in all about three hundred case reports to that date—June, 1926. It is exhaustive and leaves little to be said. Since then two additional cases have been reported —one by Loe in February, 1927, and one by Walker in April, 1927.

In this article I shall add thirty-four new cases to the literature—none of which has previously been reported. The operations were all performed at the Post-Graduate Hospital, New York City, on the combined services of the several attending and associate attending surgeons. I am indebted to these men for permission to report their respective cases.

By comparison with the total number reported to date, it would appear that the Post-Graduate Hospital has had more than its share. But according to the law of averages, this is an unreasonable conclusion. That the pathological examinations at the Post-Graduate Hospital are superior to those elsewhere is also an unreasonable conclusion. One must assume, therefore, that there is a great laxity in reporting this interesting condition; due, perhaps, to the fact that all specimens are not sent for pathological examination. Furthermore, since the condition is never diagnosed previous to operation and is practically always benign, the attitude toward it seems purely academic.

The series of cases herein reported has been collected from a review of specimens examined at the Post-Graduate Hospital during the past eight years. There were 45,302 pathological specimens in all, thirty-four of which showed malignant disease of the appendix. This incidence, therefore, is .075 per cent. of all specimens examined. Of appendices examined, the incidence is .35 per cent., which figure closely approximates that reported by numerous observers, including Reiman,[19] Meyer,[16] and McWilliams.[14]

The average age in this series was thirty-four years—the youngest patient being eighteen years and the oldest sixty-seven years. This, too, is in close accord with most of the previous reports, which, summed up, state that the disease occurs most often in the third decade.

As a matter of interest, there were selected two hundred consecutive patients from whom the appendix had been removed, either alone or in conjunction with more important surgery. The average age in this series was thirty-five years minus—almost exactly the same as in the series of carcinoma cases. It would appear, therefore, that the age incidence is of absolutely no importance, the average being the same in those with or without cancer.

The youngest recorded case is one reported by MacCarty and McGrath[13] in a child of five years; the oldest recorded case is one reported by Rogg[21] in a patient of eighty-one years.

The question of sex in this series is particularly interesting because of the great preponderance of females afflicted. McWilliams, in a collected series of seventy-seven cases of primary carcinoma of the appendix, reports forty-four, or 57 per cent., in females. Primrose,[18] quoting Boyer,[3] gives from 60 per cent. to 70 per cent. in females; Reiman[19] states: "It occurs more commonly in the female." In the present series of thirty-four cases, twenty-eight, or 82.4 per cent. occurred in the female. Compared with the other averages, this is unusually high. The Post-Graduate is not particularly a hospital for women; in fact it has a larger number of beds for male patients, and the turnover is greater on the male than on the female division.

Of the two hundred consecutive operations referred to above, where the appendix had been removed, exactly one hundred and fifty, or 75 per cent., were female. The opinion of several busy operators, expressed verbally, is that the female abdomen is subject to more surgery than the male abdomen, which in turn would account for more routine appendectomies. With a larger number of female appendices to examine, it is logical that the greater number of carcinomas should be reported as occurring in that sex.

Nevertheless, 82.4 per cent., as reported in this series, is very high. Taken together with reports of other observers, one could fairly deduce that the condition is more common in the female. Rolleston and Jones[23] state that the disease does not affect the female more often than the male.

In seventeen cases of the series, the operation was performed for colelithiasis, gastric ulcer, or fibroid uterus, and the appendix removed incidentally. In ten cases the operation was performed for acute—acute gangrenous or acute purulent—appendicitis and the cancer was discovered incidentally. In two cases the operation was performed for hernia—one umbilical, one inguinal—and the appendix removed incidentally. In five cases the operation was performed for chronic appendicitis. These facts do nothing but emphasize the casual, accidental finding of the condition. At no time, as far as the records show, was carcinoma diagnosed or suspected.

All cases were primary in the appendix and situated as follows: twenty-eight at the tip, five at the base, and one midway between tip and base. Of

the five at the base, one had penetrated the serosa, and one had metastasized to the meso-appendix. In all five a warning of the likelihood of recurrence was issued by the pathologist. They were of the columnar-cell type. The possibility of metastasis, therefore, is slight—less than .6 of 1 per cent. in this series. Even this small percentage is important, and stresses the necessity of always removing the appendix, barring contraindications, whenever the abdomen is opened.

There are two general types of cancer that involve the appendix. The first is the columnar-cell or gelatinous adenocarcinoma. This tumor does not differ from the same type of growth found elsewhere in the abdomen. It is ordinarily not found in early life and is very prone to recur. The second type is composed of small polygonal or spheroidal cells. It may occur at any age and is nearly always benign.

In the past the majority opinion has been that even though these tumors vary slightly from the usual run of carcinomas, they should be classed as such. The name carcinoid has been coined to indicate its association with carcinomas and still differentiate it from them. Other names by which it has been christened are—benign cancer, pseudo-carcinoma, and chronic hyperplastic lymphangitis. An exhaustive review of the literature, including the study of not less than eighteen articles in a variety of languages by as many authors, embracing Perret,[17] Warwick,[26] Elting,[7] Luce,[12] Deaver,[6] Reiman,[19] McWilliams[14] MacCarty and McGrath,[13] Moschkowitz,[15] Rogers,[20] Van Alstine,[25] Meyer,[16] Rogg,[21] Adami,[1] Harte,[8] Kelly,[9] Tate,[24] and others, failed to give any clue to its origin.

Primrose reports two remarkable cases of carcinoma of the appendix occurring in sisters, both of whom suffered from tuberculosis. Aided and abetted by quotations from numerous authors, he draws an excellent case for the close association as to the causative agent (except for the tubercle bacillus itself) in cases of tuberculosis in and about the appendix and carcinoma of the appendix. He also brings forward for consideration, as does Child[4] and Le Conte,[11] the possibility of heredity as a cause.

There are present excellent possibilities to fit all theories of cancer of the appendix. Being subject to all ordinary infections and having low resistance, it could carry off the honors for those who favor the infection theory. Since it is endowed with a poor blood supply, it has gained favor with the adherents of the nutritional theory. Its vestigial origin—being formed by a budding process—gives heart to the members of the biological theory.

P. Masson has carried his investigation further and has recently more forcibly stated his theory as to the origin of these tumors. To quote him: "Carcinoids result from proliferation of intra-nervous argentaffin cells of the neurocrine type. They pile up in the nerve fibres, finally rupture their sheaths, and infiltrate the intestinal tissue of the neuroma and then that of the submucosa." This is the latest word as to the cause of this interesting condition.

The search for a sufficient number of signs or symptoms upon which to base even a tentative diagnosis has borne no results. After carefully weighing all the evidence at hand, including the histories of the thirty-four cases herein reported, one can reach no conclusion nor can one make a definite, positive statement regarding a single symptom, or a chain of symptoms, that would assist in making a diagnosis of cancer of the appendix. Even if a tumor in this region were palpated—and this is quite possible—to say that it is a tumor of the appendix would not be much more than a guess.

It would seem that we are still in the dark as far as a diagnosis of this condition is concerned. In ninety-nine cases out of the next one hundred, the operator will be surprised when the pathologist reports that the appendix removed shows a carcinoma, or carcinoid, at the tip, adding a note that these tumors are generally benign and need give no concern unless they happen to be located at the base.

## SUMMARY

1. Carcinoma of the appendix is a distinct pathological entity.
2. The first authentic case was reported by Beger in 1882.
3. It is not a rarity.
4. Its incidence is approximately one-half of 1 per cent. of all appendices removed.
5. It is discovered most frequently in the third decade; the usual appendectomy—for appendicitis or of a prophylactic nature—is also performed in the third decade.
6. It will probably be discovered more often in the future.
7. More than 75 per cent. of the cases occur in the female. This is of no special significance, since the female abdomen is more subject to surgery than the male and the appendix more often removed.
8. It occurs most often at the tip and is nearly always benign.
9. P. Masson has written the latest word as to its etiology in the May, 1928, issue of *American Journal of Pathology*.
10. It has never been clinically diagnosed.
11. It produces no signs or symptoms of sufficient distinction to warrant a pre-operative diagnosis.

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# APPENDECTOMY WOUND REPAIR AND HERNIA *

## By JOHN H. GARLOCK, M.D.

OF NEW YORK, N. Y.

UP TO about January, 1921, there was a fairly definite routine on this service for the treatment of acute appendicitis. This embodied a number of principles suggested by Doctor Pool. All patients were operated upon by members of the staff of the Second Surgical Division. The McBurney incision was used in the majority of cases. Whenever any doubt existed as to the diagnosis, especially in females, a right rectus incision was made. The stump of the appendix was inverted when possible and covered with a purse string suture reinforced by a Lembert suture, both of catgut. The stump was ligated and cauterized in the presence of induration in the cæcal wall. When a large incision was necessary, partial suture of the aponeurosis was done, thereby burying foreign material and interfering with the blood supply of a tissue easily subject to bacterial infection. When drainage was indicated, two cigarette drains were used, the longer one placed directly to the area to be drained, and the shorter just into the peritoneal cavity, but not to the focus. The short drain was removed at the end of twenty-four hours, and the long one loosened, with the hope that drainage would take place around the cigarette rather than through it. When suppuration was profuse, the long drain was removed in from forty-eight to sixty hours after operation, and a tube inserted. The members of this staff feel convinced that fewer fæcal fistulæ occur with this method than when tubes are inserted at the time of operation. Drainage is employed when there is pus or when oozing is likely to occur.

During the years up to about 1921, a rather frequent finding post-operatively was necrosis and sloughing of the fascia in the wound. It was felt that this tended to increase the incidence of post-operative hernia. About this time, a change in the routine treatment of the wound was instituted by Doctor Pool, and this has been followed practically in every instance to date. In all cases of acute appendicitis where the diagnosis is certain, the McBurney incision is used. In making the intermuscular incision, an effort has been made not to hamper proper exposure by the small size of the opening. In other words, whenever necessary, the incisions have been generous. In general, after removal of the appendix, the stump is inverted. Induration of the cæcum, inaccessibility, and friability of the tissues are indications for simple ligation of the appendix stump. When drainage is indicated, one cigarette drain is placed near the stump of the appendix and another is

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* From the Second Surgical Division, New York Hospital, service of Dr. Eugene H. Pool.

inserted through the peritoneum. The latter is so placed, that, upon its removal, a wider drainage tract will result. It is usually removed in twenty-four hours. The deeper one is shortened gradually until its complete removal after forty-eight to sixty hours. When the discharge is profuse, it is replaced by a soft rubber tube. When the drainage tract becomes more superficial, the Carrel-Dakin treatment is instituted. When necessary, additional drains are placed to the pelvis or the right lumbar gutter at operation. These are gradually shortened. In most drained cases, especially when *B. coli communis* is obviously present, *the wounds are left wide open.* Very often, to prevent prolapse of bowel or omentum, a few sutures of plain catgut are placed in the parietal peritoneum. No sutures are placed in muscle, fascia or skin.

We have been greatly impressed with the change in the appearance of these wounds post-operatively. Whereas formerly fascial slough with its characteristic odor and suppuration was encountered frequently, it has been an infrequent finding since the adoption of this method of treating these wounds.

Fascial slough and wound infection following the operation for acute appendicitis with drainage may have two causes. It may be due to the use of sutures in the fascia, causing tissue necrosis of a structure susceptible to infection, or it may be due to the presence of anaërobic organisms. The few anaërobic cultures that we have made have been inconclusive. It is a subject that deserves further study. To prevent, therefore, tissue necrosis and the growth of anaërobes these wounds are left wide open whenever possible. A thin layer of vaseline gauze is placed over the skin edges to render the first dressing painless.

While the above has been the recognized routine since 1921, it was not used in every case, and there is now presented the unusual opportunity of comparing two series of cases. In one, no sutures were used. In the other, sutures were placed in either the fascia or skin or both. In addition, there is for study a series of right rectus incisions.

Of the total series of 755 cases of acute appendicitis, there were forty-seven deaths, or 6.2 per cent. Table I indicates the mortality by decades.

TABLE I.

*Mortality by Decades.*

| Age | Cases | Deaths | Mortality per cent. |
|---|---|---|---|
| From 0 to 10.. ........................... | 107 | 9 | 8.4 |
| From 11 to 20............................. | 274 | 8 | 2.9 |
| From 21 to 30............................. | 177 | 9 | 5.0 |
| From 31 to 40............................. | 112 | 6 | 5.3 |
| From 41 to 50............................. | 50 | 6 | 12.0 |
| From 51 to 80............................. | 35 | 9 | 25.7 |

A glance at Table II discloses the fact that the majority of the deaths were due to peritonitis, present at the time of operation. In the group of 236 cases labelled as closed without drainage there was no mortality.

TABLE II.

*Causes of Death in Forty-seven Cases.*

|  | Cases | Per cent. |
|---|---|---|
| Diffuse peritonitis | 33 | 70.2 |
| Abscess | 1 | 2.1 |
| Abscess with peritonitis | 5 | 10.6 |
| Embolism | 2 | 4.2 |
| Pneumonia | 2 | 4.2 |
| Pylephlebitis | 1 | 2.1 |
| Sepsis | 2 | 4.2 |
| Myocarditis | 1 | 2.1 |

For purposes of careful comparative follow-up study, these cases have been grouped as follows:

*Group I.*—Cases drained without sutures in fascia or skin.

*Group II.*—Cases drained with sutures in fascia or skin or both.

*Group III.*—Cases with right rectus incisions.

*Group IV.*—Cases closed without drainage.

*Group I.*—(Cases drained without sutures in fascia or skin.) In this group there were 290 patients. Twenty-six were lost from follow-up, leaving 264 for actual study. During convalescence, five were noted as having fascial slough. All these patients in all groups were followed from three to twenty-four months, some for thirty-six months. The average was twenty-two months. At follow-up examination, a number of patients were found to present a hiatus in the external oblique aponeurosis with an otherwise firm wound. There were twenty-eight such cases and they were followed carefully. Of these, two subsequently developed herniæ. In the entire group of 264 followed cases, seventeen developed a hernia in the scar, a percentage of 6.4. Table III shows the distribution according to decades.

TABLE III.

*Age Incidence of Hernia in Group I.*

| Age | Hernia |
|---|---|
| From 0 to 10 | 0 |
| From 11 to 20 | 2 |
| From 21 to 30 | 2 |
| From 31 to 40 | 5 |
| From 41 to 50 | 5 |
| From 51 to 80 | 3 |
| Total | 17 |

or 6.4 per cent. for Group I.

This is to be compared with the findings of Bancroft, who reported a series of cases from the same service in 1920. His paper, which included

a series of 584 consecutive cases of acute appendicitis, embodied an analysis of the mortality rate, the incidence of post-operative complications, a description of the pathology found at operation, and an enumeration of the data obtained at frequent follow-up examinations. In 295 drained cases that were followed carefully for approximately the same period as noted above after discharge from the hospital, there was an incidence of forty-five herniæ, or 15 per cent. All the patients in this group were treated according to the routine in use at that time.

*Group II.*—(Cases drained with sutures in fascia or skin or both.) There were 124 patients in this group. Twenty were lost from follow-up, leaving 104 for study. Two were noted as having fascial slough during convalescence. A dehiscence in the external oblique fascia was noted in eight cases on follow-up examination. In the total group of 104 followed cases, twelve developed post-operative ventral herniæ, or 11.5 per cent. The decade distribution of these cases is shown in Table IV.

TABLE IV.

*Age Incidence of Hernia in Group II.*

| Age | Hernia |
|---|---|
| From 0 to 10 | 1 |
| From 11 to 20 | 2 |
| From 21 to 30 | 2 |
| From 31 to 40 | 4 |
| From 41 to 50 | 3 |
| From 51 to 80 | 0 |
| Total | 12 |

or 11.5 per cent. for Group II.

*Group III.*—(Cases with right rectus incisions.) There were fifty-eight patients who had right rectus incisions. Of these, fifty were actually followed. Eight patients subsequently developed ventral herniæ, a percentage of 16.

*Group IV.*—(Cases closed without drainage.) In this group, there were 236 patients with no post-operative mortality. Of 216 followed cases, there was no instance of hernia.

*Fæcal Fistula.*—While, undoubtedly, a number of factors play a rôle in the development of fæcal fistula after the operation for acute appendicitis, we have always felt that one of the most important is the type of material used for drainage purposes. With induration of the cæcal wall, interference with circulation due to local thrombosis, operative trauma, friability of the tissues and slipping of a ligature from the base of the appendix, acting singly or combined, constituting the important predisposing causes, the final local insult is administered with the introduction of some form of rigid drainage material. It is a surprising fact that glass tubes are being used in one or two of the large clinics in this country. Many clinics use, as routine, large rubber tubes of great rigidity. It has been routine on this service to use carefully made cigarette drains. We hope to drain around the cigarette and

not through it. It is the softest type of drain at our command and will cause least pressure necrosis. That it acts effectively is evidenced by our decrease in post-operative secondary abscesses.

The diagnosis of fæcal fistula is made on the discharge of fæces from the wound and always is verified by the administration of methylene blue by mouth. In this series of 472 drained cases, there were twelve fæcal fistulæ, a percentage of 2.5. Nine of these closed spontaneously and three required operative repair.

## CONCLUSIONS

1. The only hope of reducing the mortality rate of acute appendicitis lies in early diagnosis, and early operation. In the undrained cases reported in this series there was no death.

2. The most common cause of death is diffuse peritonitis. Of forty-seven deaths in this series, 70 per cent. were due to this cause.

3. The highest mortality rate occurs in the first, fifth, and later decades.

4. The incidence of fæcal fistula may be greatly reduced by the employment of an atraumatic operative technic and the use of soft drainage material. In 472 drained cases, there were twelve fæcal fistulæ. Nine of these fistulæ closed spontaneously.

5. The number of post-operative ventral herniæ has been reduced more than half since the practice of avoiding the placing of sutures in muscles, fascia, or skin was adopted. In a group of 264 followed cases, seventeen developed a hernia, a percentage of 6.4. In contrast to this, is a series of 295 drained cases from this service, reported in 1920, with forty-five herniæ, or 15 per cent.

# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 25, 1928

The Vice-President, DR. EDWIN BEER, in the Chair

## CONGENITAL WEBBED FINGERS

DR. KIRBY DWIGHT presented an eight-year-old boy with congenital webbed finger—third and fourth fingers of each hand. On the left side the webbing extended only to the base of the second phalanx and had been operated upon previously, apparently by a simple splitting of the web. On the right side the webbing extended clear down to the tip of the finger and the tips of the distal phalanges were joined together by bony union.

The right hand was operated upon at Lincoln Hospital, November 4, 1927. The commissure between the fingers was formed by using Felizet flaps and then, distal to the site where these flaps were taken a modified Didot operation was done. The terminal phalanges were separated with a chisel. December 14 a similar operation was done on the left hand and the scar tissue of the previous operation was excised. January 30 a partial ostectomy of the distal end of the second phalanx of the right middle finger was done similar to a bunion operation. Its purpose was to correct the lateral angulation of the distal phalanx, caused by a difference in the rate of growth of the two fingers while their tips were fused together. These wounds all healed kindly, the raw areas quickly being covered with epithelium.

At the time of operation the commissure on both hands was made higher, (that is the fingers were split further), than the commissure between the other fingers. At the present time the result is moderately satisfactory. The webbing has recurred to a certain extent in spite of the fact that a good commissure was obtained on both sides. This recurrence, he believed, is due to the contraction of the scar tissue along the fingers. It was his impression that there is less likelihood of this recurrence if the Didot operation is done without using skin from the fingers to form a flap in the commissure. However, in any case with children, it is likely that with the growth of the fingers the web would be drawn down somewhat, as the scar tissue would not stretch as the fingers grew. This case was shown as an example of the fact that there may be a partial recurrence of the web even though a good commissure has been constructed.

DR. CARL G. BURDICK said that many years ago Doctor Downes taught him a method for operating on webbed fingers which he had always followed. A triangular flap is taken from the dorsum of the web with the base over the heads of the metacarpals, a vertical incision made on the anterior surface of the flap, the triangle turned in and the apex sutured in front. The denuded areas on either side of the flap are immediately skin grafted.

There have been a number of cases of webbed fingers in the speaker's service at Bellevue Hospital and none have recurred.

DR. WINFIELD SCOTT SCHLEY said he had tried all known methods of

operation for this condition. In the last analysis it is a skin graft pure and simple. The incision separating the fingers must be carried well down to between the heads of the metacarpals. The grafts have to be kept down to the very bottom, and are held there for six to seven days and then are carefully dressed. In this way one can get perfect mobility and complete freedom from recurrent webbing.

## CARCINOMA OF STOMACH

Dr. KIRBY DWIGHT presented a man aged fifty-four, who was admitted to the Roosevelt Hospital in October, 1924, with an indirect inguinal hernia, a slight prolapse of the rectum and some stomach symptoms, for whom on March 19, 1925, he had done a Polya resection of the stomach on account of a large indurated ulcer on the posterior wall of the stomach. The anastomosis was made behind the colon and the efferent loop of jejunum was placed at the greater curvature. Microscopical examination of the ulcer showed adeno-carcinoma, and the nodes along the lesser and greater curvatures were involved. The patient made an uninterrupted recovery and was discharged on April 9.

He has been seen frequently since then and has been in splendid health with no gastric symptoms. X-ray examination shows complete emptying of the stomach in six hours. When last seen, in December, 1927, there was no evidence of metastasis or recurrence.

## BILATERAL FRACTURE OF PELVIS WITH INTRA-PELVIC DISLOCATION OF THE HEAD OF THE FEMUR; FRACTURE OF HUMERUS

Dr. JOHN J. MOORHEAD presented a woman, age thirty-five, who was admitted to Post Graduate Hospital, September 24, 1926. Three days prior to admission she fell from a second story through an open window. Immediately removed to hospital. On examination there she was found to have sustained:

1. Fracture of pelvis with intra-pelvic dislocation of the head of femur (left). Both sides of pelvis involved around obturator foramen.

2. Fracture of surgical neck of humerus (right) and acromion.

3. Contusions of face and about right eye.

4. Abdomen somewhat rigid in left lower quadrant. No urinary signs. Pulsation in leg and foot normal.

The treatment applied was: 1. Traction to arm and to thigh; both in abduction. 2. October 4. Transfixion of great trochanter by nail after unsuccessful effort by manual manipulation to reduce the fracture. While pulling on the spreader attached to the nail there was a decided sense of giving; further traction caused the nail to break almost in equal parts. The anterior half could not be removed. Plaster-of-Paris spica in traction and abduction. 3. October 7. Transfixion supracondylar. Traction up to forty pounds. October 13. Traction removed from arm. 4. October 28. Removal of supracondylar transfixion and the broken nail. Adhesive traction substituted. 5. November 8. Deformity recurred: Transfixion of great trochanter through original incision. 6. November 29. Plaster-of-Paris spica. 7. November 30. Out of bed on stretcher chair. 8. December 15. Spica removed. 9. December 21. Walked with crutches. Supracondylar wounds healed. Sinus in front and behind greater trochanter. Can bear weight with aid and hip motion is fairly free. Limb swollen. Arm motion very free. February 8. Still uses two crutches. Can elevate extremity eighteen inches off table. Knee bends to right angle: hip ditto. March 15. Uses cane. Decided

limp. May 13. Swelling less marked. Pulsation normal. Wounds closed September 26. One year after injury: Limp; swelling; some soreness region great trochanter. November 16. Half inch lift on shoe improves gait.

*Present state.* Limp moderate. Swelling slight. Shortening between one-half and three-fourth inch. Wound over trochanter recently broke down and discharged for a few days; now closed.

The knee is somewhat swollen and she complains of constant pain below the kneecap. There is moderate swelling with pitting below the knee. She can elevate the thigh twenty-one inches off the table; opposite thirty-four inches. There is abduction to 45 degrees. Adduction is normal. Rotation is much limited. Can bend the knee beyond right angle and squats readily. Deep pressure over the iliac region elicits some pain and an indefinite sensation of a mass. Pulsation is normal. She wears a shoe built up three-quarters of an inch.

## KNEE-JOINT ARTHROTOMY FOR OSTEOCHONDRITIS DESSICANS

Dr. John J. Moorhead presented a girl, sixteen years of age, with the following history; in whose case an X-ray examination had shown a loose body on the under surface of the condyle of the femur close to the median line. By a mediolateral arthrotomy a dissecting osteochondritis the size of a small lima bean was easily shelled out from the site of the shadow in the radiogram. She remained in the hospital eight days. She now walks with a moderate limp and there is about 30 degrees flexion in the knee and extension therefrom is perfect. In a series of 102 consecutive arthrotomies this is the second case of osteochondritis dessicans.

## FRACTURE OF NECK OF FEMUR IN PATIENT AGED 100 YEARS AND 9 MONTHS

Dr. John J. Moorhead said he first saw this patient in consultation with Dr. Scudder J. Woolley, March 27. On February 19 she had slipped from a low chair falling gently to the floor, sustaining a disabling injury of her left hip. On the date of her injury Doctor Imboden made a series of radiograms with a portable apparatus, finding a non-displaced fracture of the neck of the femur extending from just above the greater trochanter to the lesser trochanter and the latter was entirely detached. Treatment consisted of keeping the limb at rest by the aid of long sand bags. At the time of the examination in March, the extremity could be moved freely and painlessly and there was practically no evidence of injury. The patient is slightly irrational and had been difficult to control for about ten days. Her general physical condition was remarkable for a person of her years. She was born May 14, 1827, and thus at the time of her injury she was 100 years and 9 months old. She came from a long lived family, many of whom lived for over 90 years. In 1926, she had a severe attack of cholecystitis with jaundice and fever. The day after this examination she was allowed out of bed and remained up for nine hours. Two days ago Doctor Woolley reported that she was in excellent condition, was able to walk with slight assistance and that mentally she was quite normal.

In this connection Doctor Moorhead showed skiagraphs of another patient who is now 94 years of age and who two years ago had an intracapsular fracture of the neck of the femur. The X-ray series now shown indicates bony union. This patient was seen a few days ago and she is able to walk with the aid of a cane resting on the arm of an attendant.

## SPLENECTOMY FOR GAUCHER'S DISEASE

DR. EDWIN BEER presented a man forty-nine years of age, who was admitted to the Medical Service of Mount Sinai Hospital, November 7, 1927. There the case was studied and subsequently transferred to the Surgical Service for splenectomy, with a diagnosis of Banti's disease of the thrombocytopenic type. The patient's history was briefly, that five weeks before admission he had pain in the right lower quadrant of the abdomen, which subsided in three weeks. He then developed weakness, and became anemic.

Splenectomy was performed November 22, 1927, a very large hard spleen, measuring 25 x 8 x 10 cm. and weighing 1600 gms., being removed. As Vierdot gives the average dimensions of the normal spleen at 12 x 3 x 7 cm. and the weight as approximately 171 gms., the tremendous increase in the size of the splenectomized organ is readily appreciated.

Excision was accomplished through a long subcostal incision, starting over the left rectus muscle, incising each sheath at the lateral border and running down parallel to the ribs about one and one-half inches from the arch, well over to the mid-axillary line. The pedicle was much spread out, and required multiple ligatures. There was no ascites, and the liver showed no cirrhosis, but was very large and smooth. The splenic artery showed marked arteriosclerosis, whereas the vein was soft. On cutting through the removed spleen, which was about nine times normal size, the surface looked like a section of the liver, and the macroscopic as well as the microscopic pathological report was Gaucher's disease.



FIG. 1.—Extensive peripheral arteriosclerosis in a male forty-nine years of age suffering from Gaucher's disease. (Splenectomy.)

Pre-operatively and post-operatively the family history was gone into, and no evidence of any other members of the family having this disease could be ascertained. The patient has a well brother, and five well children. The mother died at seventy-five years; cause unknown. The father is also dead, of unknown cause. The more or less characteristic pigmentation over the nose and face were never presented by this patient, and the pinguiculæ were never seen in his conjunctivæ.

The patient made a satisfactory convalescence, though owing to chromic gut knots he apparently developed some wound irritation and infection. It

was thought for a time that he had symptoms suggestive of a subphrenic abscess, but fortunately this never came to realization.

As far as laboratory reports are concerned, while in the hospital the urine was regularly negative. The direct Van den Bergh test was negative, and the indirect showed 1-200,000. The Wassermann was negative. The urobilin examination of the urine in 1900 c.c. over three days was 53 mgms.

One of the most interesting features of this case was the X-ray study of his extremities, partly carried out with the object of seeing whether any Gaucher manifestation might be found in the long bones. These X-rays showed the most extreme arterial thickening and calcification that one is likely to see. (Fig. 1.) For a male of forty-nine years such marked pipe stem vessels have never been seen by the reporter. The abdominal X-rays to determine the disease of the arteries never demonstrated these vessels, though at operation it was seen that the splenic artery was full of calcified placques and markedly arteriosclerotic.

The patient returned to the Follow-up Clinic April 21, 1928, apparently much improved in general health, having gained fifteen pounds, and feeling very well.

## PYELOLITHOTOMY—DRAINAGE NEPHROTOMY—PERSISTENT CORTICAL CALICEAL FISTULA

Dr. Edwin Beer presented a woman to illustrate an unusual complication following pyelotomy and drainage nephrotomy, and at the same time to call attention to a procedure which has been recently suggested by one of Professor Alessandri's assistants in Rome.

The patient had three stones in the kidney, two apparently being in the cortex and one in the pelvis. The stone in the pelvis, despite the patient's size (she weighed about 220 pounds) was fairly easily removed by pyelotomy, but it was impossible to feel or locate two smaller stones which were apparently shut off in a calyx, and they therefore could not be removed through the pelvis. To recover these stones a small nephrotomy incision over the position of the stones was made, in the hope that through this drainage tract the stones might eventually be washed out.

The wound was slow in healing, and under the thick layer of fat a complicated suppurating sinus developed, which had to be split and left wide open. During all this time there was a small amount of urinary leakage, and on repeated cystoscopies (at which time the pelvis of the operated kidney was irrigated with indigo blue stained solution) none of this irrigating fluid appeared in the lumbar wound. Just as the wound was gradually closing but still leaking, a small stone about 1 cm. by ¼ cm. was fished out of the bottom of the sinus, and it was then hoped that the urinary leakage would cease. This leakage was never a great amount, but sufficient to keep the patient moist. It seemed to him that the nephrotomy incision had probably traversed a closed-off calyx which contained the two small stones, and that the presence of these small stones kept up the connection of the calyx with the lumbar wound.

Following the recovery of this last stone, two X-rays still showed a tiny stone, about the size of the head of a pin, which had been present at the original examination. Urinary leakage continued despite repeated irrigations of the pelvis of the operated kidney with antiseptics. The third stone never could be felt with a probe, and despite repeated curettings and attempts to fish out possible ligatures or foreign bodies with a crochet needle, and notwithstanding irrigation of the wound, as well as the pelvis, with a 1/2000 hydrochloric acid solution to dissolve the remaining phosphatic stone, the urinary leakage persisted, though the patient's general health was perfect and the kidney had improved in its function very materially.

This type of complication has been very rarely seen, and the persistent leakage had suggested the advisability of removing the whole organ, which might have been done if the second kidney had been a perfectly normal one. At times the patient would be dry, and then it was hoped the sinus was definitely closed. At the next visit, the leak had reappeared, and the sinus would admit a probe two or three inches. Heliotherapy was tried locally to stimulate, without any apparent results.

Having tried all the above measures locally in the wound, including iodinization, a strong solution of silver nitrate, hydrochloric acid, curetting, stretching, as well as irrigations of the kidney to control the infection and heliotherapy as a constitutional stimulant, we were pretty well at our wits' end when an article was published by Vittorio Ghiron, of Professor Alessandri's Clinic in Rome. This article appeared in the *Zentralblatt für Chirurgie* of May 14, 1927 (p. 1229), and the author suggested the use of a paste for the closing of persistent fistulæ, reporting its use in bladder fistulæ. This paste is made up of Kollagen 60 to 70 per cent. and iodin, thymol, and formol, each 3 to 6 per cent. The substance is melted over a water-bath and injected when fluidified. It rapidly hardens and fills the sinus. This substance, after having been used with success in two suprapubic fistulæ, was tried on this patient, the material having been obtained from Rome through the courtesy of Professor Alessandri. Following one injection this fistula (which had been present from the time of operation, thirteen and one-half months previous) immediately closed, and the patient has remained dry since the middle of January.

A letter received from Doctor Ghiron of Rome states that in some clinics it has been used also in vesico-vaginal and recto-vaginal fistulæ. For the benefit of those who may wish to use this new mixture, he added to the letter of November 19 sent to him from Rome, which describes the technic used, as follows:

"For the use of the Kollagen, you must melt it in water-bath or upon a lamp and then pour it out on a little warmed board. Mingle it with the powder and let it fall on the fistula little by little in way of covering it completely. Pay attention to put a considerable quantity of Kollagen on the skin all around the fistula because a greater surface of adherence may be formed by this system. Remember that the Kollagen solidifying becomes quite a third of the former volume. In the suprapubic fistulæ I often mingle the Kollagen and the powder in the fistula, mixing the two substances with a little spatula. In the narrow and very deep fistulæ you could inject it with a syringe (possibly metallic), taking care to warm it first. In this case the quantity of powder to be added must be very little else it would solidify all at once in the syringe and the injection could not be possible.

"Having put in the Kollagen I cover it with dry gauze leaving a Nelaton catheter for several days, and I keep the patient resting. When the Kollagen begins to detach I use damp hot applications to help the complete detachment and the cicatrization. When the fistula is large. I must use the Kollagen a second time. In Germany where I was asked to send the Kollagen it was used also for vesico-vaginal and recto-vaginal fistulæ. In this case the quantity of powder must be greater in order to solidify rapidly the Kollagen. One could also use one or two stitches to dry quicker the margins and then cover with the Kollagen."

## OSTEOMYELITIS

Doctors Fenwick Beekman and Carl Burdick presented a group of cases in illustration of the paper of the evening.

# CONSERVATIVE OPERATIONS IN CHRONIC OSTEOMYELITIS

DR. WALTER M. BRICKNER said that, in the treatment of chronic osteomyelitis, as evidenced, for example, by the presence of a bone sinus, the practice has been very general of proceeding at once to a radical osteotomy —chiseling away bone about the sinus and then removing still more until there is created a boat-shaped cavity ("saucerization") made contiguous with the wound margins by packing it with gauze. This plan of attack is based upon the presumptions that by free osteotomy one can remove the d i s e a s e, leaving only a h e a l t h y column of solid bone, and that by providing a properly shaped trough, definitive healing of the wound from the bottom will be g r a d u a l l y effected. This primary radical osteotomy and saucerization, without waiting for involucrum or s e q u e s t r u m, is an essential part of the Orr method, which also involves extensive and prolonged immobilization of the entire extremity in plaster-of-Paris applied directly over the dressing.

DOCTOR BRICKNER said that he had become c o n v i n c e d that *primary* radical osteotomy and saucerization, which he had been taught to follow, is often unnecessary and usually involves prolonged hospitalization and invalidism. He called attention to a paper read by him before the American Medical Association in 1925, and published in the *J. A. M. A.,* vol. lxxxv, p. 1782, December 5, 1925.



FIG. 1.          FIG. 2.          FIG. 3.

FIG. 1.—Case 1.—May 26, 1926. Extensive necrosis involving two-thirds of the shaft of the humerus with only slight involucrum formation.

FIG. 2.—Case 1.—Six months later, November 13, 1926. A very solid supporting involucrum has formed and there are now three sequestra lying in three discrete cavities.

FIG. 3.—Case 1.—One year after Fig. 2 (November 19, 1927). The humerus now shows a fairly normal shaft of healthy bone with no cavity and no area of necrosis. No operation for the chronic osteomyelitis was performed in this case except the simple removal of the three sequestra shown in Fig. 2.

DOCTOR BRICKNER then demonstrated the following cases:

A girl now about twelve years old, who, in June, 1926, was admitted to the Hospital for Joint Diseases. She had been operated on some months before for acute osteomyelitis of the right humerus and had three moderately discharging sinuses leading to the upper half of the shaft of the bone. Röntgenograms showed two-thirds the length of the diaphysis extensively porous, necrotic, with two incompletely formed sequestra, and with only beginning involucrum formation. (Fig. 1.) If a radical operation had

Fig. 6.—Case 2.— October 17, 1927. Six and one-half weeks after Fig. 5. The bone cavity is much smaller.

Fig. 5.—Case 2.—September 2, 1927. About seven weeks after simple sequestrectomy. Note that the cavity is smaller.

Fig. 4.—Case 2.—August 17, 1927. One month after simple removal of sequestrum from the cavity in the upper third of the tibia.

then been performed, removing all the diseased bone, fully half the length of the humerus would have been resected, and in the almost complete absence of involucrum to bridge this defect, the arm would have collapsed. The child was discharged from the hospital under observation, and readmitted five months later (November, 1926), at which time röntgenograms showed that there was a well-formed supporting involucrum and that the process of necrosis had resolved into three slender sequestra each about two inches

long, lying in three separate cavities communicating with the three sinuses. (Fig. 2.) An incision was made through each of these, the cloacæ in the bone were enlarged only sufficiently to remove the sequestra by morcellation, and a small gauze wick was inserted into each cavity for drainage. These were removed in a few days. The wounds closed over rapidly and completely and have remained soundly healed ever since (now a year and a half.) Röntgenograms today show the humerus as a solid shaft of healthy bone, *with no cavities.* (Fig. 3.)

The child has also had osteomyelitis of the right clavicle, the left humerus and the left tibia, all treated by similar quite conservative measures, and all at this time healed.

A little boy was admitted to the Hospital for Joint Diseases July, 1927, with an osteomyelitis of the tibia of two months' standing. A suppurating sinus in the skin led into a large cavity in the shaft, containing a good-sized sequestrum, and discharging through a comparatively small opening in the bone. The latter was enlarged sufficiently to extract the sequestrum. The cavity was drained with gauze only until the discharge was serous. Then the drain was discarded and the skin was allowed to heal over the cavity. It has remained solidly healed and röntgenograms have showed progressive diminution and final disappearance of the cavity. (Figs. 4–7.)

A little girl was admitted to the orthopædic service of the Hospital for Joint
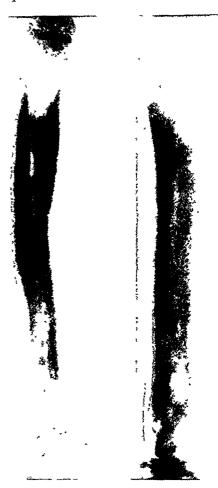


FIG. 7.— Case 2.—April 20, 1928. Six months after Fig. 6. The cavity as such has disappeared. No operation was done for the chronic osteomyelitis in this case except the removal of the sequestrum from the bone cavity over which the skin soon healed and has remained well healed. Note that the röntgenogram shows a small focus of bone absorption in the lower third of the tibia. Here a small abscess formed in January, 1928, and closed after simple incision.

Diseases July, 1927, with what was believed to be a pyarthrosis of the right hip, and high fever. Exploration of the hip by one of the staff was negative. A septic condition continued and suppuration in the soft parts was drained by an incision in the lower thigh and one above the hip. In spite of these the high fever persisted when, on August 31, the child was transferred to Doctor Brickner's service. At that time a röntgenogram showed only what appeared to be a pathological fracture through the neck of the femur, without displacement. Two weeks later, however, a röntgenogram showed also rarefaction and beginning necrosis of the trochanteric region and ten days later röntgenography showed this area extensively

broken down. It is evident that treatment by osteotomy of this diseased area would have meant resection with consequent great shortening of the extremity. The high fever continuing, Doctor Brickner made an incision over the trochanter, evacuating a little pus from beneath the aponeurosis, and removed a small piece of the diseased bone for examination. This showed a non-specific osteomyelitis—nothing suggestive of neoplasm, tuberculosis, or syphilis. (The Wassermann reaction was negative.) A fenestrated plaster-of-Paris spica was applied. All three wounds very soon healed and the fever disappeared. A röntgenogram in December, 1927, showed bony regeneration of the diseased area. The case was removed in February, 1928. The child is entirely well.

These three cases are all of small children, but the speaker has secured the same results with such conservative measures in adults with chronic osteomyelitis.

The operations in these, as in most such cases, are comparatively minor and often involve little or no confinement to bed. They are contrary to the widely accepted belief that sound healing cannot take place over a "dead space" in the bone, that overhanging bone must be removed, and that healing must take place from the bottom. That belief was also opposed as an argument when Doctor Brickner began his treatment of chronic bone abscesses by simple evacuation through a small drill hole. Yet he has shown again and again that such chronic abscesses are usually sterile, or contain attenuated organisms, and that simple drill drainage not only promptly relieves pain but, also, is followed by definitive healing even though the bone cavity, small or large, cortical or medullary, may remain indefinitely.

## ACUTE HÆMATOGENOUS OSTEOMYELITIS

Dr. Fenwick Beekman read a paper with the above title, written in collaboration with Dr. Carl G. Burdick, for which see page 270, Annals of Surgery, vol. lxxxviii.

Dr. Carl G. Burdick said that it is surprising how many surgeons fail to realize that in the early stage of an acute osteomyelitis the X-ray is negative, and that operation must be performed before any bony changes are revealed to accomplish the ideals we are striving for. The radical methods of several years ago in which a large part of the cortex was removed have been discarded, and the simpler methods of drainage are now giving satisfactory results without the destruction of a large amount of normal bone and periosteum.

In the chronic cases the problem has not been solved as satisfactorily. Sub-periosteal resection of a large part of the shaft of the bone involved, he believed was no longer considered a wise procedure. At Bellevue they have been very conservative and have only removed the sequestra after they are entirely separated, through small incisions, but this has resulted in the children being hospitalized for many months.

Dr. Frederic W. Bancroft said that Doctor Beekman has stressed an important point on the necessity for the preservation of the blood supply

in operation, and to create surgical drainage with as little trauma as possible. The process appears to him as an embolus occurring in the terminal branches of the nutrient artery: The primary suppuration occurs about this embolus, so that the pus extends rapidly to lie beneath the periosteum. At the same time there is a retrograde thrombosis of the vessels, producing the death of bone. The points that seem to establish this pathology are: 1. That the pain always starts in the neighborhood of the metaphysis. 2. That if cases are operated on early, the percentage of cases developing late necrosis is markedly reduced. 3. Those cases that are operated upon late almost always have sequestrum formation. 4. The sequestration usually follows definite anatomic lines, either from one metaphysis to the distribution of that branch of the nutrient artery, or from one metaphysis to the other—that is, the distribution of the entire nutrient artery.

Dr. Seward Erdman said that surgery for this condition has certainly undergone marked improvement in recent years. Another aspect is the patient's side of the question; what is to guard him against subsequent attacks of osteomyelitis? Has Doctor Beekman any statistics as to the percentage of cases that have recurrence. Not rarely these patients have osteomyelitis in childhood, a remission of two or three years and then recurrence in some other bone, and so on through life. What is the cause of this and wherein is the defect? It is easy to say they have lowered resistance to staphylococcus infection. The theory of latent infection in the affected bone is illustrated by a case reported by Dr. Walton Martin. A boy had osteomyelitis of the tibia and two years later had osteomyelitis of the radius. During his first stay in the hospital he had complained of pain in the wrist. A picture of the wrist was taken which seemed to show a slight change in the radius. There was temporary redness and swelling but these subsided and the patient went home. A year or two later the radius flared up and had to be opened and drained. The theory was that at the time of the original infection of the tibia some emboli had lodged in the radius and remained quiescent for years.

Another theory is that reinfection occurs from some active but perhaps hidden focus elsewhere in the body. The work of Dr. Robert A. Cooke, in showing with what frequency a chronic antrum infection is due to staphylococcus and may play an important part in the etiology of disease of the respiratory tract, was applied by the speaker with quite convincing results to two obstinately recurring cases of osteomyelitis. One of these cases was treated conjointly with Doctor Cooke and in both cases a chronic antral infection, unsuspected by the patient, was shown by X-ray and by culture from the sinus. The clearing up of the antrum infection has to date given freedom from recurrence of bone abscess. Doctor Erdman believes that heretofore not enough attention has been given to this phase in the etiology of recurrent osteomyelitis.

Dr. Alexis V. Moscicowitz said that there is a patient who first entered Mount Sinai Hospital, thirty years ago with osteomyelitis, went home apparently cured, but ever since at intervals of a few years comes back with a

history of having been treated at other hospitals. He has had thirty or forty major operations and has forgotten the number of minor operations. The speaker had often heard Doctor Brewer say: "Once a case of osteomyelitis, always a case of osteomyelitis." It is impossible to foretell if any patient will always remain well when once apparently cured.

DR. CHARLES E. FARR said that many surgeons did extensive operations as a result of having their curiosity aroused by röntgenograms. Personally he always left these patients alone as far as possible. But the X-rays had proved useful to him by revealing lesions that might otherwise have been overlooked and that were possible foci for trouble later on. In this way a considerable number of Brodie's abscesses have been discovered by routine X-rays.

In children the healing and absorbing powers are very great. Lesions of considerable extent will disappear under rest, sunlight and good food. Once the tension has been relieved by suitable incisions in the soft parts, supplemented with bone removal if deemed necessary, nothing is lost by giving plenty of time for nature to exert her powers.

DR. JOHN J. MOORHEAD stated that as he understood it the Orr treatment was a combination of débridement, vaseline gauze packs and immobilization. This was practically the same as the so-called Bipp treatment which had a short vogue in France during the war where it was sponsored by the British. In so far as technic is concerned it is the exact opposite of the Carrel-Dakin method which is meticulous in care and subsequent management. This let alone and immobilization treatment is certainly anything but surgical, as he understood it, the dressings are not changed until they become foul enough to make an actual stench.

The speaker was in accord with Doctor Moschcowitz's quotation which being paraphrased is "Once an osteomyelitis, always an osteomyelitis". The longest quiescent period with which the speaker was familiar was in the case of a patient who came into his Clinic at the Post Graduate with a spontaneous fracture of the upper end of the humerus at the site of an osteomyelitis which had remained dormant thirty-nine years. Doctor Moorhead expressed his doubt of the permanence of cure by any of the methods of the present day treatment, and felt that if cases were followed long enough they would continue to show recurrence.

DR. EDWIN BEER mentioned a patient in whom he had done a total removal of the fibula for osteomyelitis with bacteriæmia, but the bacteriæmia continued and other foci developed and the patient died. The most deplorable of all these cases were those Doctor Erdman had referred to with multiple lesions and at the present time the problem they present is most discouraging. In one such case he had tried weekly intravenous gentian violet and while the treatment was going on a new focus developed.

DOCTOR BEEKMAN, in closing, agreed with Doctor Brickner that in the treatment of chronic cases one can often remove the sequestrum through the sinus, and that the cavity will promptly close. He had noted that in

doing this some marrow was often removed with the sequestrum, demonstrating that new marrow is frequently formed around the sequestrum.

The speaker could not conceive the thromboembolic theory of bone destruction in acute osteomyelitis. He had noted that in the cases with early suppurative arthritis that the lesion in the bone did not spread if the joint had become infected. He believed that any outlet for the pus, whether into the joint or into the soft parts, will often prevent further spread within the bone. The speaker did not believe it possible to infect a bone through a drill hole. As to the recurrences of new lesions, these did not amount to more than 15 per cent., though if an individual developed a secondary lesion others were very apt to follow.

As to the source of the blood infection producing the secondary lesions, the speaker stated that they could come from a bacteriæmia resulting either from the primary lesion or one of the secondary lesions. Doctor Beekman believed that in the cases of staphylococcus aureus that the re-infection usually came from the bone lesion. In those cases of streptococci infections, he believed a primary lesion in the tonsils or pharynx was accountable. As to the question whether the removal of a bone in the early stages of an osteomyelitis will cure the disease, the question was purely theoretical. In Doctor Beer's case the cure did not occur.

In the beginning of an osteomyelitis if there is continuous bacteriæmia, one does not know whether it is produced by the focus at the point of entrance or the bone lesion. If it is produced by the latter lesion resection of the bone will possibly remove it. The speaker stated that he had tried to lay stress in his paper upon the fact that in treating these cases one is caring not only for the osteomyelitis but often for an active blood infection, the former being but a complication of the latter. In this type of case death frequently takes place within the first three days of the disease, but it is the result of the sepsis, not of the osteomyelitis.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 5, 1928

The President, DR. ASTLEY P. C. ASHHURST, in the Chair

DR. CALVIN M. SMYTH, JR., Recorder

## OSTEITIS FIBROSA CYSTICA

DR. HUBLEY R. OWEN and DR. SEARLE LANYON reported the case of a colored man of uncertain age, who was admitted to the Philadelphia General Hospital, February 5, 1928, with an injury to the left leg which he had acquired forty-eight hours before admission. He gave a history of having had a fracture of the right ankle twenty years ago, at which time he was incapacitated for three weeks. He did not have a physician in attendance at that time, but states, "two old colored men fixed" his leg for him and he had no subsequent trouble. He had gonorrhœa fifteen years ago and also had a chancre the same year. About four years ago he complained of pain in the lower end of his spine, which came on suddenly and which was not caused by trauma. He complained of pain on stooping or on walking. He had X-ray studies of his spine in the Germantown Hospital. He remained in this hospital for two weeks. He was then discharged and has had no further trouble with his back.

Examination revealed external rotation of the right foot; pain on motion of the right hip and three quarters of an inch shortening. The blood Wassermann was negative.

X-ray examination resulted in the report of an intertrochanteric fracture of the left femur. The bones of the sacrum, entire pelvis, both femora and proximal fourth of the right fibula, all the lumbar and dorsal vertebræ, both scapular, both humeri, the distal ends of clavicles, proximal fourth of the radius and ulna, the ribs, mandible, cervical vertebræ, and the bones of skull and face showed a peculiar rarefied condition. Numerous trabeculæ were demonstrable particularly, in the lower vertebræ, pelvis, femora and the heads of the humeri. There was a synostosis between the tibia and fibula at the distal fourth of the right tibia. The latter may have been fractured. Whether this is osteomalacia or an osteitis fibrosa cystica is indefinite. Singularly, the distribution of the involvement is analagous to that seen in carcinoma.

Biopsy on a specimen removed from the left femur below the point of fracture showed the following: "Cortex is thin. The surface appears rough. A ragged looking medulla containing several fatty areas. The bone tissue is hard. Microscopically the section shows the cortex of the bone markedly thin. The external surface shows irregular areas of absorption. The inner side as well as the medullary and cancellous portions show areas of absorption and replacement of loose œdematous fibrous tissue. No giant cells are found in these tissues. Primary and metastatic growth can be ruled out. Histologic picture is suggestive, but not absolutely typical of osteitis fibrosa cystica." (Dr. W. B. Belk and Dr. T. J. Jodzie.)

The speaker called attention to the diversity of opinion as to the pathological status of this condition and quoted at some length from numerous

authorities. The most recent opinion expressed in the Robert Jones Birthday Volume in June, 1928, classifies fibrocystic disease of bones into five groups as follows:

1. Cases with multiple cysts, fibrosis and malacia confined to a few bones, occurring in young people.



Fig. 1.—X-ray showing appearance of bone in case of Osteitis Fibrosa Cystica. The same appearance was noted in pictures of all the long bones of the body.

2. Multiple cysts with fibrosis and predominant general malacia, occurring nearly always in women.

3. Multiple cysts with fibrosis, general malacia and hyperostosis.

4. Cases with cysts, fibrosis and giant cell tumors, but no marked malacia.

5. Cases with cysts, fibrosis and giant cell tumors, with malacia and with or without hyperostosis.

These patients become severely deformed, bedridden and eventually die

## EPSTEIN'S NEPHROSIS (LIPOID NEPHROSIS) SIMULATING TUBERCULOUS PERITONITIS

Dr. Hubley R. Owen and Dr. Helen Ingleby reported the case of a colored boy, aged sixteen years, who was admitted to the Tuberculosis Department of the Philadelphia General Hospital, February 16, 1928, with the chief complaint of swelling of the abdomen. There was nothing in his family history suggestive of tuberculosis or malignancy. He gave the history of having been treated in the Ruth Hospital for Consumptives in 1926 and later sent to a sanatorium for the treatment of tuberculosis. His present illness dates from January 20, 1928, when he became suddenly ill with nausea, vomiting, lassitude and constipation. He complained of a dull pain in the lower part of the abdomen; developed dyspnœa on slight exertion, polyuria and nocturia and swelling of the abdomen. No hæmaturia.

Physical examination showed puffiness of the face; the abdomen distended with fluid and œdema of the ankles. The heart and lungs were clear. Blood pressure 100/50. The temperature was irregular, rising to 102° before death. The pulse ranged from 80 to 150. The respirations which were 24 on admission increased gradually to 60. The urine was dark amber in color. Albumen varied from a trace to a very heavy cloud; leucocytes, epithelial cells and hyaline casts were also found.

*Blood analysis.*—The blood was old rose in color with colloidal milky appearance. Chemical analysis showed urea 75, uric acid 4.2, cholesterol 700, creatinin 5.6, chlorides 562, sugar 0.107, carbon dioxide 25 per cent. *Cytology.*—Red blood cells 2,080,000, hæmoglobin 11.8 per cent, white blood cells, 97,000, polynuclears 84 per cent, lymphocytes 16 per cent.

The first diagnosis made was that of tuberculous peritonitis and the patient was transferred to the surgical service. Abdominal paracentesis was performed and 4000 cubic centimetres of milky fluid was withdrawn. The patient grew weaker and complained of abdominal pain. He died March 9, 1928.

At autopsy both pleural cavities were found to contain about 200 cubic centimetres of pink milky fluid, apparently a blood-stained transudate. The pericardial sac contained about ten cubic centimetres of yellow opalescent fluid. The abdomen was distended and the peritoneal cavity contained about one-half litre of milky fluid. In the pelvis and behind the ascending colon the fluid contained thick flakes of fibrin. Part of the surface was smooth and glistening. Fibrinous flakes were adherent to the ascending colon and sigmoid. The kidneys were considerably larger than usual. The left measured 15.5 x 8.5 x 5 centimetres and weighed 400 grams. The right was slightly smaller. The capsule was thin and stripped easily. The surface was smooth except for the remains of fœtal lobulation. It was mottled red and gray, or grayish-yellow and stippled with gray and yellow points. The substance was soft and œdematous and had a somewhat greasy feel. The cut surface was likewise mottled. The cortex was extremely wide—1.5–2 centimetre—and stippled with gray and yellow. These gray and yellow dots represented dilated tubules. The glomeruli were just visible. The medulla was darker than the cortex, but the distinction between the two was blurred, more so than is usual in this condition. The pelvic fat was not abnormally increased. The vessels were not prominent.

*Examination* revealed enormous dilatation of the tubules. The dilatation affected chiefly the convoluted tubules. These dilated tubules were lined by flattened cells. Sometimes these cells bore a faint likeness to the normal, but mostly they were flattened beyond recognition. The lumen contained a pink staining substance, sometimes homogeneous, sometimes granular. This substance stained faintly yellow-red with sudan and very faintly with scharlach r. The loops of Henle were a little dilated and contained

the same kind of substance. The collecting tubules were somewhat dilated; some contained homogeneous material. The glomeruli were scattered owing to the increase in the size of the tubules. They showed multiplication of the nuclei, swelling and granular degeneration of the protoplasm. Sometimes they nearly filled the glomerular space, but more often the space was distended with a homogeneous material resembling that found in the tubules. The interstitial tissue was increased, especially in the medulla; with fat stains this was seen to be due in great part to a deposit of lipoids. Much of the fat was contained in wandering cells. With scharlach r, it stained bright red, with sudan III, yellow-red, and with nile blue, pink. This is characteristic of cholesterin esters. Apart from the fat-containing cells, round-cells resembling lymphocytes were fairly numerous. Fat-containing cells were found here and there in the lumen of the tubules. The vessels were inconspicuous. When examined carefully, fat-containing cells were found within them, also minute droplets of fat lying in the interstitial spaces between the red cells.

The heart muscle was pale and the left ventricle showed no hypertrophy; microscopically the cells contained fine droplets of fat. The liver showed fatty infiltration and the Kupffer cells contained cholesterin esters. The lungs showed patches of bronchopneumonia, and one of the glands at the hilum of the right lung contained pus. There was no evidence of tuberculosis in any of the organs. Bacteriological examination of the heart's blood, lung, and pelvis showed *B. coli communis.*

Except for the terminal rise of non-protein nitrogen in the blood, this case was a typical one of Epstein's nephrosis. In the kidney, however, the lipoid, instead of being chiefly in the tubules, was found in the interstitial tissue. The reason for this was probably that the lipoid-containing cells of the tubules had all been shed and had disintegrated. Some of the lipoid had been passed in the urine, some carried into the interstitial tissue by wandering cells. The flattened cells which replaced the normal epithelium were apparently not capable of being filled with lipoid. One would argue from this that death occurred at a late stage of the disease. It is possible that his sojourn at a sanatorium in 1926 in reality marked the beginning of his nephrosis.

DR. HUBLEY R. OWEN remarked that the condition known as Epstein's nephrosis is closely related to chronic parenchymatous degeneration of the kidney and other organs; the condition is more a medical than a surgical one—the only surgical aspect being the peritonitis which simulates tuberculous peritonitis. The interesting thing about this patient was that he had been in the ward for treatment for tuberculosis and had been in two other hospitals for treatment for this condition; yet the post-morten showed no tuberculous process.

DR. HELEN INGLEBY said that Epstein believes that the condition is a metabolic disturbance and is due to an abnormal fluid in the kidney, which is excreted just as sugar is excreted in diabetes. Jelwin, however, believes that it is primarily a kidney defect and that the rest of the disturbance follows it. It is sometimes associated with myxœdema, in some cases it may be bad, in others it may be on the border-line, and in still other cases it is much benefited by the administration of thyroid extract. An interesting point is that in the clear-cut cases there should be no nitrogen retention; in this case, there was. However, some time toward the end of the disease it may

happen. In pure uncomplicated cases apparently the kidney can excrete anything quite easily, and the only reason it may not be excreted is that the fluid goes into the tissues and never reaches the kidneys; if it reaches the kidneys it will be excreted. In the typical case fat should be found in the tubules, but this case was so advanced that the tubules were not capable of holding any more fat. The finding of ascites chylosus in Epstein's nephrosis is a common occurrence. In this case there was no obstruction of the thoracic duct at autopsy.

### SPINDLE-CELL SARCOMA OF THE FOOT

DR. WALTER G. ELMER presented a man, twenty-four years of age, who was admitted to the Orthopædic Dispensary of the Graduate Hospital of the University of Pennsylvania, August 4, 1925, complaining of pain in the left foot. He walked with a slight limp. For two months he had noticed a small, firm mass below and in front of the external malleolus which was slowly increasing in size, was tender and caused pain. The ankle-joint motion was normal and the tarsal mobility normal. He was admitted to the hospital and the mass was dissected out without cutting into its capsule. It was imbedded in the soft tissues outside the joint capsule and overlying the joint between the astragalus and os calcis. The pathologist's report on this tumor was spindle-cell sarcoma. The patient was then referred to the X-ray department for treatment. X-ray examination showed no disease of the bone. Later examination, taken in December, 1925, showed such marked absorption taking place in the astragalus and os calcis that the reporter was unable to determine whether this was due to the X-ray treatment or to a return of the growth. The scar tissue seemed to be healthy. An exploratory operation was made. X-ray of the lungs showed no metastases. The scar tissue was dissected out and bone shavings reamed out of the decalcified area. Frozen sections showed no evidence of tumor tissue. The wound was therefore packed with gauze and allowed to heal. The patient has remained in good health, has no symptoms whatever and walks with a natural gait, and tarsal mobility is normal. X-ray examination made May 26, 1927, shows the astragalus and os calcis completely returned to normal.

By way of contrast DOCTOR ELMER presented a man, aged twenty-two years, who was brought to the speaker, October 3, 1928, with the history that in January, 1928, he struck his knee when he fell down several steps, but did not realize he had done himself any injury until a month later, when his knee became swollen and painful. When first seen the region of the right knee was much enlarged—the mass was firm and dense with two discharging sinuses. The knee was flexed about twenty degrees and there was very little joint motion. The patient was thin, pale, and looked very ill. There were firm nodular masses in the right groin. He was admitted to the Graduate Hospital. X-ray showed a tumor mass surrounding the lower end of the femur, the bone had the appearance of an osteomyelitis of the epiphysis and lower portion of the shaft. On the anterior surface of the shaft there was an elevated strip of periosteum. The cartilages of the knee-joint seemed to be normal and the joint itself had not been invaded. Cultures from the sinuses showed staphylococcus aureus and hæmolytic streptococcus. The diagnosis of osteogenetic sarcoma with metastasis to the groin was made. X-ray of the chest showed extensive involvement of both lungs. There was nothing to be done except advise the patient to return to his home.

DR. WILLIAM J. RYAN said that he had had under his care a woman, aged sixty-two years, who, in September, 1926, had struck her knee which

was followed by the development of a small lump. This was removed and she came under the speaker's care in May, 1927, at which time she had a recurrence of the lump. The mass was situated just below the tibial attachment of the patellar ligament and a biopsy was done—the laboratory report being spindle-cell sarcoma. The mass stripped off the periosteum of the tibia very easily. There did not appear to be any involvement of the bone. Local recurrence occurred within one month's time and the patient refused amputation. It was therefore treated by electrocoagulation and X-ray and removed, but recurred again in two months' time. She refused to have anything done until the mass grew to an enormous size, and because of this, and also because of the odor, she consented to an amputation which was done in July of this year (1928). Repeated X-ray examinations of all the other bones were negative. X-ray of the chest was negative. There seemed to the speaker to be several unusual things in connection with this case—first, the age of the patient, *i.e.*, sixty-two years, and second, the recurrence at the local site with no evidence of metastases anywhere. The patient is now in good general condition.

Dr. George M. Dorrance said that in his experience with cases of sarcoma of the limbs there is an apparent disposition to metastasis in the opposite extremity. He feels that it is more liable to be to the limbs than to the lungs. In these cases even amputation does not offer a great deal and the speaker thinks the results are better from treatment with the X-ray without operation than with operation.

Dr. John H. Jopson said that fibrosarcomata of the foot have a tendency to recur and that this has always been recognized in the literature. The speaker operated, a number of years ago, when a patient who had been operated upon two or three times, over a period of years, before the final amputation to which he later succumbed. It was Doctor Jopson's recollection that in the literature the consensus of opinion was that cases of this kind and in this region did recur. Spindle-cell sarcoma—not osteogenic sarcoma—arising in the fibrous portion of the periosteum or the fibrous tissue show a prompt tendency to local recurrence in the foot.

## EMPYEMA AND SUPPURATIVE PERICARDITIS: THORACOTOMY AND PERICARDIOTOMY

Dr. Damon B. Pfeiffer reported the history of a boy, aged fourteen years, previously healthy, who was admitted to the Presbyterian Hospital May 28, 1928. Three weeks before admission he developed a cough and pain in the right chest. That night he had a chill, followed by nausea and vomiting, and thereafter ran a typical course of severe right-sided lobar pneumonia. In ten days he improved apparently by crisis, but his cough continued and breathing became more difficult. The cough though persistent was unproductive. On the day of admission his temperature ranged between 99° and 101.6°, his pulse between 124 and 148 and his respirations between 40 and 54 per minute. He was extremely pale and obviously very sick. He presented the signs of a massive collection of fluid in the right pleura. The heart seemed to be pushed well over to the left. The sounds were of fair quality and no adventitious sounds were detected. The urine showed a trace of albumin and many granular casts. The leucocytes numbered 11,000 per cubic millimetre with 75 per cent. polymorphonuclears. The X-ray verified the presence of fluid, filling the chest to the line of the second rib. On the

day following admission his condition seemed so grave that it was decided to remove a quantity of the pus by aspiration before attempting a thoracotomy, and 122 cubic centimetres of thick greenish-yellow pus was withdrawn from which a pure culture of pneumococcus was isolated. This was followed by a fall in temperature, pulse and respiration with evident clinical improvement. Two days later, under local anæsthesia, a resection of the ninth rib was made in the mid-axillary line. Following this, although drainage was satisfactory, he failed to improve as might have been expected. The temperature gradually rose, reaching 104° in the evening, three days after operation, and the pulse hovered around 130. The respirations, however, diminished in number, averaging about thirty per minute. Dakinization of the pleural cavity failed to reduce the toxæmia. Physical examination at this time showed an unusually large area of cardiac dulness and the possibility of pericarditis was considered. June 7, the report of an X-ray examination by Doctor Newcomet stated "from the character of the heart shadow it would appear as if there was some fluid in the pericardium. The transverse diameter of the heart at the base is sixteen centimetres while at the base of the auricle it is thirteen centimetres. Right and left diaphragm can be seen, though both are hazy."

The following day pericardiotomy was performed under local anæsthesia. There was no difficulty and the patient did not experience the slightest discomfort. A double curved incision was made, as described by Doctor Pool, beginning over the sternum at the base of the fourth costal cartilage. The skin and superficial fascia were dissected back on each side, exposing the costal cartilages, and from one to one and a half inches of the fifth, sixth and seventh cartilages were resected. The intercostal muscles and posterior perichondrium were then incised, exposing the internal mammary artery which was tied at the upper and lower angles of the incision. The triangularis sternii muscle and the fatty areolar tissues were displaced outward, exposing the pericardium. The pleura was not defined, being covered by and displaced with the above tissues. It is worthy of note here that before incising the intercostal muscles the heart could be felt beating forcibly immediately beneath this layer, and when an exploratory needle was introduced to reinforce the conviction that the pericardium contained fluid, none was obtained. When the pericardium itself was exposed, however, and it was possible to insert the needle obliquely between the membrane and the apex, which was pounding against it, fluid was at once obtained, which was turbid and slightly flaky. Culture subsequently showed the pneumococcus. This illustrates the difficulty which may be experienced in obtaining fluid by simple paracentesis in early cases, before the effusion has attained a large size. The pericardium was then incised and found to contain about 150 cubic centimetres of thin purulent fluid. The serous surfaces were slightly dull, but there was no adherent fibrin. The incision was extended longitudinally for about two inches, its lowermost point being at the extreme diaphragmatic attachment. Two soft rubber tubular (Penrose) drains were then placed in the bottom of the sac and fixed to the pericardial edge. A single stitch was taken through the skin above and below, the pericardium being completely exposed, and dressed with a light gauze pack placed over the wound.

The beneficial effect of this procedure was at once apparent. The signs and symptoms immediately improved. On the second day the wound was dressed with the intention of beginning Dakinization of the sac, but the wound was found to be filled with yellowish, rubbery fibrin, evidently coagulated exudate. The drains were embedded in this mass and it was clear that they were completely isolated from the pericardial sac in the same manner and by

the same mechanism as abdominal drains after the first few hours. Irrigation with Dakin's solution was, nevertheless, begun hoping to sterilize the sinus and dissolve the exudate. The fibrin, however, failed to dissolve and the temperature after falling for five days again rose and remained between 101° and 103°. This condition was maintained practically without change for several weeks.

June 22, X-ray showed the right lung expanded with no change in either size or shape of the heart. June 27, a blood transfusion was given but with no observable improvement. The persistence of the fever in the absence of blood-stream infection made the reporter fear that the fibrinous exudate in the pericardium was breaking down and forming encapsulated collections, which it would be difficult or impossible to drain. However, about this time, the temperature began to fall gradually and except for an exacerbation due to the formation of a small pocket at the base of the right pleura, which was detected by lipoidal and drained by inserting a longer tube, the patient recovered without further incident. The tube was removed from the pericardial sinus and the patient discharged August 11, 1928, after an illness lasting thirteen weeks from the onset and about eight weeks from the pericardiotomy. .

November 5, approximately three months after leaving the hospital, an electrocardiogram by Dr. James Talley showed a flattening of all the "T's" in all of the leads which, in the absence of cardiac medication, is interpreted as being indicative of myocardial change. Aside from a slight rapidity of the pulse, the patient is quite normal, but Doctor Talley advised that he be kept on cardiac rest for some time.

Doctor Pfeiffer remarked that of suppurative pericarditis, Osler said "probably no serious disease is so frequently overlooked by the practitioner". As to its frequency, Cutler states that in an analysis of 3683 necropsy records, at the Boston City Hospital, Locke found 150 instances of acute pericarditis, and of these only twenty-seven or 17 per cent. had been diagnosed clinically. Evidently it is not only the general practitioner who overlooks these cases. Stone, in a study of 300 fatal cases of pneumonia, found pericarditis in seventy-two cases, in forty-four of which the fluid was purulent. Suppurative pericarditis should be considered as a possible complication, especially, in pneumonia, osteomyelitis, or other septic states that present a puzzling and otherwise unexplainable toxæmia. Once the diagnosis is reasonably established there should be no hesitation or delay in resorting to surgical treatment, without which the mortality of reported cases, now in the neighborhood of 130, is over 50 per cent. Many of these cases were late and some died of associated lesions. Certain cases, apparently moribund, recovered by release of the pressure of the exudate upon the heart, the so-called cardiac tamponade, which prevents the venous blood from reaching the chambers of the heart. The operation itself is simple and singularly devoid of inherent complications. It lends itself readily to local anæsthesia. Adequate drainage for an adequate period of time is the prime essential. This has been accomplished successfully through a great variety of approaches: (1) through the sternum; (2) to the right of the sternum; (3) to the left of the sternum, (a) by intercostal incision, (b) by trap-door incision, (c) by excision of one, two or three costal cartilages; and (4) by xiphisternal incision. The method employed in this case was that described by Doctor

Pool at the first joint meeting of this Academy with the New York Surgical Society in 1920, and published in the ANNALS OF SURGERY in April, 1921. This was a slight modification of the method of Délorme and Mignon. It would seem to be of almost universal applicability in its simplicity, adequacy of exposure and dependence of drainage. The methods, materials and even the necessity of irrigation are not entirely settled. A fair number of cases have recovered without employment of any irrigating fluid. In the case here reported, owing to the rapid formation of fibrinous coagulum, it is doubtful if more than the drainage sinus itself was reached by the Dakin's solution employed. But this was an early case and a strong bodily immunity to the previous pneumococcus infection was undoubtedly present. Cases presenting greatly dilated sacs and heavy exudate would be a different problem and irrigation would seem indicated. It has been established that a large variety of mild antiseptic substances may be tolerated as irrigation materials. Their relation to subsequent pericardial adhesions remains to be demonstrated. While very early cases may do well on simple postural drainage, it is probable that the majority will require the assistance of irrigation to carry off the excess of exudate and prevent subsequent pocketing in the lateral and posterior recesses of the pericardium.

DR. JOHN H. JOPSON remarked that he assumed charge of this patient in Doctor Pfeiffer's absence from the city and pursued his policy of masterly inactivity with continuous amazement that a patient as sick as this young man was—with elevated temperature, etc.—should continue to do so well. He was able to sit up in bed, to eat and to read. No factor was present which necessitated interference. The speaker has been interested in the report on certain cases many years later. One case which Doctor Porter reported before the American Surgical Association last year, was a patient who had been operated upon by Doctor Porter's father. He had been an interne at the Massachusetts General Hospital at the time. He was reported as being alive and in good health, this being many years after operation. The prospect for a good functional and organic recovery is excellent. The pictures which Doctor Pfeiffer showed indicate that there was a change in the angle at which the pericardial shadow appeared in its relation to the diaphragm. As the patient progressed to recovery there was a change in this angle and a diminution of the shadow on the opposite side. The speaker has now at the Graduate Hospital a case in which the patient was operated upon seven weeks ago for a mediastinal dermoid of the right chest, associated with bronchiectasis of the lower portion of the right lung, which led to the diagnosis of pulmonary abscess. She progressed toward recovery until recently when she has had dyspnœa, orthopnœa, and rapid pulse. The heart shadow is still large. At the time of operation Doctor Jopson thought that the pericardium might have been injured. It is important to follow such cases in later years. The eventual result is inclined to be satisfactory.

DR. GEORGE P. MULLER said that shortly after Doctor Pool read his paper on this subject, he had a case of suppurative pericarditis with pleural effusion.

The patient was nine years of age, had had influenza and pneumonia and was very ill. He also had an area of osteomyelitis of the lower end of the femur. The patient did not do so well with drainage. The diagnosis of suppurative pericarditis was made and the röntgenogram showed abnormal dilatation of the heart. Doctor Muller operated upon him by the method of Pool and removed one pint of pus from the pericardial sac. A Dakin's tube was introduced and the patient made a good recovery. The pleural cavity was aspirated twice for fluid. He was seen three times in the next year and curettement performed for the osteomyelitis. He was then lost sight of until very recently. He is now sixteen years old. He had no dyspnœa, and no heart murmurs, and Doctor Wolferth reported that there was no essential change in the action of the heart as shown by the electrocardiogram. However, the X-ray of the heart showed an aneurysm of the ventricle. He has no signs of such a condition and it may be due to adhesion of a portion of the heart to the pericardial sac. Whether he actually has a hernia of the heart muscle is uncertain and there is some question as to doing an operation for the purpose of severing such an attachment should it exist.

DR. A. P. C. ASHHURST, to illustrate the danger of indiscriminate puncture of the pericardium, referred to the following patient who came under his care.

A boy ten years of age with what his family doctor thought was pericarditis. This physician called, as consultant, a specialist in children's diseases. This specialist concurred in the diagnosis and inserted a needle into the region of the heart in four places, but without finding any fluid. The child went into collapse after the punctures. The consultant withdrew the needle from the pericardium and himself from the consultation. The family physician, finding his patient rapidly growing worse, had him transported to the Episcopal Hospital and asked the speaker to see him. He found the little boy apparently moribund, pale, pulseless, and almost apnœic and evidently suffering from compression of the heart by a massive effusion. Under local anæsthesia he inserted a needle just to the left of the ensiform and, on the second puncture, dark blood came in spurts on removal of the obturator. The costal cartilages of the sixth and seventh ribs were then resected and the pericardium exposed; it was about two or three millimetres thick. When it was opened, disorganized blood was ejected with great force in spurts, so that it was thought by Doctor Ashhurst's assistants that he had wounded the right ventricle. The patient improved as the blood continued to flow, the pulse and respiration slowing. The boy awoke as if from the dead and asked if he might have some ice-cream—this was given him on return to the ward. The pericardium was drained by a rubber catheter. Almost two litres of old blood were evacuated from the pericardial sac. The child failed to recuperate, however, and died thirty hours after operation. After death, exploration of the wound showed the heart contracted in systole, and a little bloody serum in the pericardium. Evidently the consulting specialist had punctured the heart and it continued to bleed into the pericardium until the outside pressure sealed the opening into the heart.

## PERFORATION OF PEPTIC ULCER

DR. HENRY P. BROWN, JR., read a paper with the above title for which see page 209.

DR. CHARLES F. MITCHELL said that his personal experience was that fifteen or twenty years ago there were more perforations than we have today. Patients complaining of indigestion come earlier to treatment. Formerly at

the Pennsylvania Hospital, cases in which a positive diagnosis could not be made were recorded as cases of general peritonitis, but the speaker thinks many of these were perforations into the lesser peritoneal cavity. The speaker took exception to Doctor Brown's remarks on anæsthesia; he still prefers ether in these cases to nitrous oxide and oxygen. It gives greater relaxation and in his experience has not been followed by post-operative pneumonia any oftener than after nitrous oxide or oxygen anæsthesia. The operative procedure depends upon the condition of the patient and the judgment of the surgeon; each case should be a rule unto itself. Doctor Mitchell has never done a resection nor a posterior gastro-enterostomy in a case of perforated ulcer. He believes that these cases should all be drained and a wick of gauze put in a suprapubic stab wound. He had yet to regret putting a drain in anybody.

Dr. George P. Muller remarked that Doctor Mitchell stated that he has never yet regretted the putting in of a pelvic drain. In ten years the speaker has not used a pelvic drain and has only had cause to regret this once. That patient had to be operated upon three months later for lower abdominal symptoms, at which time a half pint of mucoid material was removed, after which he recovered. Another case of perforated ulcer which was cauterized and sutured and a gastro-enterostomy done, is now suffering from hæmorrhage, evidently with recurrence of the ulcer. Three days ago he operated upon a patient with a perforated duodenal ulcer. This man was familiar with his condition and as soon as he felt the symptoms at once called a taxi and came directly to the hospital. He had had his office telephone his doctor who met him at the hospital and he was operated upon in less than two hours from the onset of the pain. To do a subtotal gastrectomy in perforated duodenal ulcer would be foolish, but the speaker tries to do a gastro-enterostomy in every case. In the little over half of the cases in which it was not done, the patients have come back with trouble and it has had to be done in the end. Some men believe that only the patients who are not very ill should have gastro-enterostomy. Doctor Muller thinks the ones who are sicker seems to do better with gastro-enterostomy and at once get relief from the pounding against the duodenum and thereby have a better chance for recovery.

Dr. Hubley R. Owen recalled to Doctor Muller the case of a policeman upon whom operation was performed three-quarters of an hour after perforation, which happened while he was in Doctor Owen's office. The man was taken to St. Agnes Hospital and Doctor Muller operated upon him at once. Two weeks ago a second case of perforation occurred while the man was in the office and he was operated upon within a half hour. This year there have been seven cases of perforated peptic ulcer among the policemen and firemen. The one death occurred in a case in which the ulcer was destroyed by cautery. One case perforated during the course of a suppurative appendicitis and general peritonitis. This patient recovered and is doing traffic duty.

Dr. Edward J. Klopp recalled the case of a man operated upon two years

ago for carcinoma of the tongue and while being treated for this, had a perforated ulcer. A gastro-enterostomy was performed and he recovered. He was seventy years of age. As to the question of drainage, last year, Doctor Gibbon had a patient at the Jefferson Hospital who had been operated upon eighteen years before with a diagnosis of bacterial peritonitis. There was a great deal of pus between the diaphragm and the liver and a drain was placed beneath the liver and also one beneath the diaphragm. The patient died thirty-six hours later and the post-mortem showed a large necrotic area in the diaphragm. About the same time the speaker operated upon a man, fifty years of age, and for the same reason placed a drain beneath the diaphragm. He developed empyema and died from a perforation of the diaphragm, approximately two inches in diameter. Doctor Klopp said that he will never again place a drain beneath the diaphragm following an operation for perforation. He agreed with Doctor Muller that the post-operative results are better when gastro-enterostomy is done, provided, of course, the case will permit of such procedure.

Dr. Emory G. Alexander said that the great majority of medical students seem to have been taught that one gets shock in perforated duodenal ulcer. He had never seen it except late in the case, when peritonitis has occurred. The speaker did not quite agree with Doctor Mitchell that there are not as many perforations recently as there were years ago. He has three cases under his care at the present time. In 1914 or 1915 he reported a series of twenty-five or thirty cases with discussion as to whether or not gastro-enterostomy should be done. Gibson, of New York, had written on that subject. These cases reported to Doctor Alexander's office and were questioned without looking up the histories to see whether or not gastro-enterostomy had been performed. From the end results he was unable to determine which patients had had gastro-enterostomy and which had not. The speaker feels that if the patient has a more or less acute perforation with no induration a gastro-enterostomy need not be performed. Gastro-enterostomy is indicated, however, when the induration is too great to allow satisfactory closure of the ulcer. It is unwise to advocate any one procedure when so many varieties of treatment are possible. He had never seen a recurrence in a perforated duodenal ulcer treated by simple closure, but had seen two cases recur after gastro-enterostomy; one with perforation of a gastrojejunal ulcer and the other with perforation of a jejunal ulcer. Cultures from the ulcer itself, in the upper and lower peritoneal cavity, are usually negative. The speaker believes that it is safer to drain than not. The drainage does no harm and can usually be taken out in a few days.

Dr. Charles F. Nassau said that the various opinions as to operative procedure represent a difference in surgical judgment. Whether this judgment is based upon logic or upon the whim of the individual it is hard to say. As to the type of anæsthesia: many use local anæsthesia because they believe it to be a safeguard against pneumonia, yet we must admit that there are a certain definite number of pneumonias following the use of local anæsthesia,

regardless of the type of operation—even outside of the abdominal cavity. Everyone has probably seen a statement made by von Haberer's assistant that, although he operates under splanchnic anæsthesia, just as many pneumonias develop as when he used a general anæsthetic. Of course, there are other reasons for using local anæsthesia. In an elective operation there is no doubt that the patient enjoys an easier convalescence. The speaker agrees with Doctor Alexander that the wisest thing to do in perforation of peptic ulcer is a simple closure of the ulcer. Years ago he did gastro-enterostomy for this condition and it is not a much more difficult procedure, nor does it take a much longer time to perform. However, the length of operation is not the main consideration; there is the matter of extra tissue damage and whether the procedure is necessary. Gastro-enterostomy can always be done later if the post-operative condition shows that something else is needed. This is Doctor Nassau's feeling at the present time, and unless something extraordinary developed and he thought the lumen of the duodenum was in danger of occlusion he would not do gastro-enterostomy.

The question of drainage is interesting. With increasing experience all surgeons use less and less drainage in the so-called "bad" appendix cases. Experience has taught us much about the closure of bad wounds within a few hours, after complete disinfection. The speaker believes that if in perforated duodenal ulcer operation is done within six or eight hours after perforation, drainage is never necessary unless there are some conditions that make it clearly advisable. However, care should be used in teaching this theory to students. In making a decision between gastro-enterostomy and pyloroplasty, a pyloroplasty should not be done in an acute condition. To perform it or a Kocher's gastro-duodenostomy is infinitely more difficult and dangerous than to do gastro-enterostomy.

DR. IRVINE M. BOYKIN said in regards to the closure of abdominal wounds that the catastrophe of having them break open can be avoided by making the incision in more than one plane. In operations on the stomach and epigastrium, a right paramedian incision, whereby the rectus muscle is lifted and retracted outward and the posterior sheath opened beneath, gives an incision in three planes. In the closure of wounds the use of the splint suture of silkworm gut 1 centimetre or 1.5 centimetre apart in support of the catgut sutures is an excellent preventive. Drainage in perforated ulcer cases, at the site of perforation, is seldom necessary. Seepage from the upper abdomen is collected in the pelvis and a drain in the pelvis should be sufficient. Posterior gastro-enterostomy *per se* does not cure ulcers. The speaker thinks that posterior gastro-enterostomy should not be done unless a closure of the ulcer cannot be effected.

DR. A. P. C. ASHHURST said that Doctor Alexander has raised the question as to the existence of shock in any case of gastric or duodenal perforation. Hence it is pertinent to ask the question, "What are the symptoms of shock?" The symptoms of shock are torpidity of mind, paleness or faint cyanosis of the body, and rapid pulse. The speaker once talked to Dr. John

B. Deaver about the occurrence of symptoms of shock after perforation. Doctor Deaver had just read Moynihan's paper in which he asserted there was no shock in such cases. Doctor Ashhurst wrote to Doctor Deaver outlining the symptoms as he had seen them in a case of perforation: the patient was torpid in mind; pale—almost cyanotic—in body; and indifferent to his surroundings. But his pulse was slow. To this Doctor Deaver replied: "I would say that this was shock." The slowness of the pulse is the only feature which is unusual in typical cases of shock, and is probably due to absorption of duodenal contents from the peritoneal cavity. Bradycardia is not an infrequent symptom in biliary obstruction. It is, however, quite true that shock is very unusual in cases of gastric or duodenal perforation.

No one has mentioned what to do with perforations that one cannot suture. A piece of omentum can be sutured over rather insecure sutures. and usually it will keep the perforation closed. But this plan will not succeed unless some kind of suturing is used. In two patients the perforation occurred in the middle of an indurated sieve-like area where no suture would hold and the speaker was forced to tampon the area. He thought the patients would leak gastric juice and die but both of them recovered.

Regarding gastro-enterostomy the speaker is eclectic. He thinks that it should be done whenever it is justified. If he thinks it will kill the patient he does not do it. No one but the surgeon operating can decide this. Two patients, in whom the perforated pyloric ulcer was closed without gastro-enterostomy primarily, have returned complaining of symptoms of indigestion for which a secondary gastro-enterostomy was done.

DR. WILLIAM J. RYAN said that in two of his cases of perforated ulcer the wounds broke open but smears of them failed to disclose the presence of pathologic bacteria at any time, nor was any gross pus present. He, therefore, concluded that leakage of the gastric contents occurred through the suture lines, causing the wounds to become digested. The wounds were splinted with silkworm-gut sutures about one-half inch apart.

DR. HENRY P. BROWN, JR., added that all three types of ulcers were included. Gas oxygen anæsthesia was used. In 1927 the records show ten cases of perforation and fifty-four cases with other diagnoses. In 1924 the records showed nine cases of perforation and forty-six other diagnoses.

# BRIEF COMMUNICATION

## THE HARPANAHALLI BEZOAR

IN ADDITION to the "Bezoars" mentioned in the October, 1928, issue of the ANNALS OF SURGERY I may add one more kind of Bezoar to Doctor Maes' classification. This kind of Bezoar is caused by a pill said to be made out of the blood of a species of chameleon in combination with certain other indigenous East Indian drugs. This was used by certain Brahmin widows of the Western Taluks of the Bellary District (Madras Presidency) to cause the slow decline and death of strangers who happened to share their table. There is a superstition among them that this mode of doing away with young and energetic men—mostly executive officials—paves the way for their salvation. Whatever the object might be, the bolus of food in which it is administered forms the Bezoar, with the minute pill as the nucleus, and the food around never gets digested. This is proved by the fact that even after six months the vomited Bezoar, if it fortunately occurs, contains the very food in which it was administered originally. This kind of Bezoar acts in the same manner as all the others and causes symptoms akin to them.

The pain and uneasiness in the epigastrium begins about a fortnight after the administration. Intense gastritis and active dyspepsia set in. There is some accompanying fever also, and the patient ultimately dies of slow inanition in from three to six months. Though this Bezoar is comparatively small, it does not come out in the vomit, nor does it pass the pyloric sphincter. The horrible practice has become practically extinct; although some sporadic cases do still occur here and there.

The above history was gotten from the few patients who have survived the ordeal with the help of prompt and proper treatment. This treatment consists in giving a green shrub internally, which is with difficulty found in those parts; and this acts by bringing the Bezoar along with the vomit or allowing it to pass through the pylorus and be discharged in the fæces. But it is indeed fortunate for the stranger that this is almost a bygone practice at present.

This pill is said to have been originated at Harpanahalli, the intellectual centre of that district, and goes by the same name; and hence we may also name this condition as "Harpanahalli Bezoar."

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S. V. NATHAN, M.D.,
*Madras, India.*

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# MEMOIRS

## FREDERIC KAMMERER
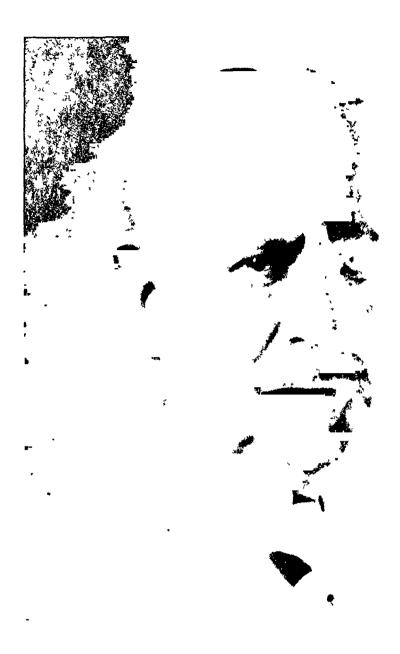
### 1856–1928

On September 26, 1928, Frederic Kammerer died at Merano, Italy, in his seventy-third year. For several years he had been suffering from a rather marked arterial hypertension, and he finally succumbed to a cerebral hæmorrhage. Until his fatal attack he had been mentally alert as ever, and he was fortunately spared the period of invalidism and helplessness which he so dreaded.

Frederic Kammerer was born in New York City February 4, 1856. His father, Dr. Joseph Kammerer, was of Swiss birth, being brought to this country at the age of four. Educated in Europe, he returned to New York City, taking up the practice of medicine, specializing largely in gynecology and obstetrics. He was one of the founders of the present Lenox Hill Hospital, then known as the German Hospital, and at the time of his death in 1875 he was professor of obstetrics at the Medical School of New York University. Doctor Kammerer's mother, Léonie von Weisseneck, was descended from an Austrian family of some distinction which had settled in Germany.

Doctor Kammerer's elementary education was obtained in private schools in New York City, and later in the Polytechnic Institute at Karlsruhe, Baden, Germany, from 1872 to 1875, when, on the death of his father, he returned to America. Within a year he left again for Europe, to begin the study of medicine at Freiburg. He received his doctor's degree in Freiburg in 1880. For one year, 1878 to 1879, he was an assistant in the Anatomical Institute of Professor Robert Wiedersheim, at Freiburg, and after graduation, for four years, from 1881 to 1885, he was assistant at the Surgical University Clinic in Freiburg, first under Professor Hermann Maas, and later under Professor Paul Kraske. For half a year in 1885 he was an assistant at the Gynecological Clinic of Professor Carl Schroeder, in Berlin, and for nearly a year, 1885 to 1886, he worked in the laboratory and assisted in the Medical Clinic of Professor Ludwig Lichtheim, at Berne, Switzerland.

With this very thorough general and special training, Frederic Kammerer came back to New York City in November, 1886, to take up the practice of surgery. In 1889 he was appointed Attending Surgeon to the German Hospital of New York City, later the Lenox Hill Hospital. This position he held until he retired on reaching the age limit of sixty-five years in 1921, when he was made Consulting Surgeon to this institution. In 1890 he received the appointment of Attending Surgeon to St. Francis' Hospital, of New York City. He held this position until 1911, when he became Consulting Surgeon

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to this hospital. From 1900 on he held the position of Consulting Surgeon to St. Mary's Hospital, Hoboken, New Jersey. He was professor of Clinical Surgery at Cornell University Medical College from its foundation in 1898 to 1909, and he held a similar position at the College of Physicians and Surgeons, Columbia University, from 1909 to 1921.

In November, 1915, he headed a hospital unit sent to Germany by the American Physicians' Expedition Committee. This unit took charge of a military reserve lazaret at Deutsch-Eylau, West Prussia. Doctor Kammerer remained there until May, 1916. Though not at all in sympathy with Germany in the World War, it was quite in line with his character that he felt impelled to offer his services to the country where he had obtained his medical training, in grateful part-payment for what she had given to him.

In April, 1917, he accepted a commission as Major in the Medical Corps of the United States Army. He organized and became the Director and Chief of the Surgical Service of Red Cross Base Hospital No. 16, recruited from the German Hospital of New York City. This unit was later assigned to United States Army General Hospital No. 12, stationed at Biltmore, North Carolina. Doctor Kammerer went on active duty in March, 1918, and remained in the service as Surgical Chief of this hospital until after the armistice, being honorably discharged December 3, 1918.

In 1907 he was married to Miss Ida Knapp, the daughter of the late Dr. Herman Knapp. Mrs. Kammerer survives the doctor. They had no children. Doctor Kammerer retired from practice in November, 1921. His permanent address thereafter was Berne, Switzerland.

Doctor Kammerer had been a Fellow of the American Surgical Association since 1899. He was a member of the New York Surgical Society and its president from 1913 to 1915. He was also a member of the International Surgical Association, the American Gastro-enterological Association and the Deutsche Gesellschaft für Chirurgie, and a Fellow of the American College of Surgeons, and of the New York Academy of Medicine.

Though not a prolific writer, Doctor Kammerer made a number of important contributions to the literature. The one upon which he always looked with the greatest pride was on gonorrhœal arthritis, published in 1884, while he was an assistant at Kraske's Clinic in Freiburg. In this "Arbeit" he was the first to show the presence of the gonococcus in the joint, and the first, therefore, to prove it to be the cause of the articular inflammation. Perhaps his best-known contribution to surgical technic was made in 1897—the description of the so-called "right rectus" incision for appendicitis, known in America as the "Kammerer incision." In 1899 he reported a successful ligation of the first portion of the subclavian artery for aneurysm. His patient lived for four weeks. He was expert in thyroid surgery, and was among the first to demonstrate the technic of thyroidectomy in America.

Doctor Kammerer's surgical contributions were by no means confined to his published papers. He disseminated his views and the fruits of his rich experience by personal contacts and particularly through his society discus-

sions—especially in the American Surgical Association and in the New York Surgical Society. With a clear, logical mind and a wide, intelligent vision, he contributed much valuable thought on these occasions. It can be truly said that he was one of the pioneers of our modern American surgery.

At the time Doctor Kammerer returned to his native land, the aseptic era was just dawning. By teaching and example he helped to spread the doctrines in this country on which our subsequent surgical development rested.

There was a strong humanitarian side to his character which manifested itself in his tender devotion to his patients, whose welfare was his primary concern. To his assistants he was a most particular and exacting taskmaster, though he was never unkindly, and invariably just and fair. He had a sense of honor and a purity and nobility of character that are rarely met with. He had great capacity to charm and attract people, but was rather reserved and sensitive. He much preferred the companionship of a few intimates, who, recognizing his sterling qualities and his really affectionate disposition, loved him dearly.

Personally he was above all a courtly, cultured and scholarly gentleman of the old school. Of a very studious turn, he read much, both in his special field and in general literature, even during his latter years, and after he had retired from active work. Aside from his profession he had numerous and varied interests. He was an ardent lover of nature, and had traveled and hunted in many of the wilder parts of this country and in Europe. He enjoyed visiting his friends and colleagues in the various medical centres of the Old World, and traveling after his retirement and settlement in Europe became one of his main hobbies. He himself was a collector of etchings and engravings. He was passionately fond of music, of which his knowledge was profound and his appreciation very keen. He was an excellent performer on the 'cello. He was an active and enthusiastic member of the Charaka Club, that famous group of leaders in medicine who gave some of their thought and attention to the literary, historical and cultural aspects of their calling.

This summarizes the life and work of a great and modest soul that has passed on. He was a man of great versatility and unimpeachable character, a gifted, high-minded and universally-respected surgeon. His influence will be felt for many years to come and his work will endure. To those who were privileged to know him intimately, his death brings a sense of irreparable personal loss.

DeWitt Stetten

# HOWARD A. LOTHROP
## 1864-1928

Dr. Howard A. Lothrop, who died June 4, 1928, was born in Sharon, Massachusetts, December 31, 1864, the son of Horace A. and Sarah Gorham (Swain) Lothrop. As a boy and student he was greatly interested in natural history, especially ornithology. He made a wonderful collection of birds, which he prepared and mounted himself with remarkable skill and success. The deftness of hand developed in this way in youth contributed not a little to the skill which he afterward displayed as a surgeon. He attended the Boston Latin School, entered Harvard College and graduated *magna cum laude* in the Class of 1887. In 1891 he graduated from the Harvard Medical School, where he led his class, with the degrees of M.D. and A.M. He studied in Vienna for two years; then served as House Officer at the Massachusetts General Hospital. Entering practice in Boston, he soon received an appointment as Surgeon to Out-patients at the Boston City Hospital, where he did excellent work, rising through the grades to Surgeon-in-chief. His surgical work was skilful, conservative and successful. At one time he did some brilliant work on the ligation of arteries for aneurysm. He was one of the early contributors to our knowledge of epigastric hernia. He was Instructor in Surgery in the Harvard Medical School from 1903 to 1912, Assistant Professor of Surgery from 1912 to 1922, and Acting Professor of Surgery, 1922–1923. He devoted a great deal of care to the preparation of his lectures and clinics, never missed his appointments with the students, and took special pains to give adequate instruction in surgical technic. For many years he was a contributing member to the meetings of the American Surgical Association.

Howard A. Lothrop, M.D.

Doctor Lothrop made an enviable reputation for himself as an expert witness in accident cases. He was fair, conservative and accurate in his statements, and his counsel was often sought by accident boards and corporations in the disposition of such cases. He was very fond of music, was a skilful musician, and had a fine tenor voice, which he cultivated until he became a welcome singer at evening entertainments. He sang for many years in the Harvard Alumni Chorus. He took great interest in the "Doctors", a social club formed around the members of the Class of 1891 in the Medical School, of which he was a member. He never married and lived with his mother, who survives him, as do his two brothers, Dr. Oliver A. Lothrop, of Boston,

and John Howland Lothrop, of Portland. Oregon, and three sisters. He was a hardworking, faithful and skilful surgeon, and, as a result of his skill, gained a large practice and many enthusiastic admirers. He had retired from the staff of the Boston City Hospital in January, 1927, but continued to attend to his large private practice. He was one of the youngest-looking men among his contemporaries, and although never athletic, except in his college days, kept in fine bodily condition.

His death was caused by septicæmia, which resulted from an infection of his thumb, pricked by a safety-pin two weeks before. This infection proved fatal in spite of all efforts, including amputation of the arm. He bore his last illness with amazing fortitude and faced the amputation with unshrinking courage.

F. B. LUND

## SYPHILIS AND SURGERY

### By George Gellhorn, M.D.

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THERE are so many syphilitics in the world that we are bound to encounter a certain proportion of them among the patients on whom we are about to operate. Cones[7] estimates this percentage as high as eighteen. Have they as fair a chance of recovery as nonsyphilitics? Are they "poor surgical risks"? Must we expect definite complications and take special precautions? Does their disease alter the general aspect of the case as far as diagnosis and indication for operation are concerned? All these are questions which a thoughtful surgeon will put to himself.

In trying to formulate an answer I find it impossible to limit myself altogether to gynecology, simply because the subject has thus far attracted too little attention in my own specialty. Moreover, the problem affects any surgeon, no matter what his special line of work happens to be.

Two ways by which surgical patients may come to harm on account of their syphilis immediately suggest themselves to us.

1. Through errors in diagnosis such patients may be subjected to unnecessary and even dangerous operations. That mistakes of this kind occur is, after all, not surprising. A disease like syphilis, which appears in a thousand-fold deceitful disguises, might well produce manifestations which resemble conditions calling for operative intervention; and indeed there is hardly a surgical affection of any part of the body that at one time or another has not been mimicked by syphilis.

Nuzum[23] collected a long list of needless surgical operations from failure to recognize tabes. In one instance the patient had five laparotomies, the last three for postoperative adhesions; and following each operation the old symptom of epigastric pain, with severe vomiting, returned—that is, the gastric crisis of tabes.

In 200 cases of osseous syphilis under the observation of Stokes[28] the proportion of surgical error reached 21 per cent. "Osteosarcomas" that in reality were syphilitic manifestations have many times been treated surgically (Lustgarten, Fordyce, and others); and there is one case on record where an arm was amputated in a boy of nine because of such a diagnostic error.

Sheeley[26] mentions several cases of gumma in testicles removed with the wrong diagnosis of malignancy or tuberculosis.

Gaucher[11] speaks of a case of amputation of the penis with excision of both inguinal glands for a supposed cancer which in reality was a chancre; and Mewborn,[21] writing in the pre-Wassermann days, records a similar case which is instructive because of the mistake in diagnosis and the fact that the therapeutic test with mercurial inunctions, mixed

treatment, etc., was used, but not in sufficient dosage to yield results. The man presented the initial lesion on the penis but no secondaries. One year later amputation of penis for "carcinoma" and removal of inguinal glands. Ten years later, V-shaped excision of "epithelioma" of lower jaw. Since then secondaries in various parts of the body. Cure following energetic antisyphilitic treatment.

In the case reported by Fabian[9] an ovarian tumor had been removed by operation with the diagnosis of sarcoma. Five years later "metastases" appeared below the left costal arch. As the Wassermann was strongly positive, atoxyl treatment was given which brought about the complete disappearance of the tumor. In the retrospect it is clear that the metastasis as well as the original ovarian tumor were gummata, not sarcomatous, and would have required no operation.

I[12] have reported a case where, even after the abdomen was opened, I diagnosed an inoperable cancer of the liver until the course of convalescence made me change my diagnosis to one of gumma and enabled me to cure the patient permanently by anti-syphilitic treatment.

Instances of chancre or gumma of the cervix uterus, wrongly diagnosed as cancer, have been recorded in the international literature so frequently that I have devoted a separate paper to this subject.*

As to uterine hæmorrhages, I refer to Mouchotte,[22] who performed hysterectomy on a young woman because he failed to recognize in time the syphilitic nature of her metrorrhagia. Among the cases of backache reported by Roberts,[27] there was one of operation for uterine displacement, but the symptom which had been caused by syphilitic myositis did not clear up until mixed treatment was given. In the case of Joltrain[16] a woman of twenty-seven was operated on with the diagnosis: appendicitis or salpingitis, and the appendix was removed. After a short post-operative improvement the old gastro-intestinal symptoms returned in a greatly aggravated form. The difficulty of interpreting these symptoms and the history of a miscarriage early in married life led to taking a Wassermann, which was positive. The spinal fluid likewise gave a positive reaction and, moreover, showed a marked lympho-cytosis which, according to Widal and Ravant, is typical of secondary syphilis. Energetic intravenous treatment completely relieved all symptoms within twelve days.

Stein and Hensel[31] operated upon a woman of sixty-four with a negative blood Wassermann for a large intra-abdominal tumor supposed to be either an ovarian cyst, a pedunculated fibroid or a cyst of the omentum. At laparotomy the abdominal cavity was found empty, and the tumor was discovered to be a gumma of the abdominal wall with beginning suppuration. After operation the pathological behavior of the reflexes and the strongly positive Wassermann of the spinal fluid led to the diagnosis of tabes. Under energetic antisyphilitic treatment, the tumor disappeared within two months. The authors quote three similar cases from the literature.

Recasens[25] performed a vaginal hysterectomy suspecting cancer of the body of the uterus. The specimen, however, exhibited only a fungous thickening of the endometrium with numerous small scars. Microscopically, there were extensive perivascular infiltrations and endo-arteritic proliferations which in places had caused a complete obliteration of the blood vessels. The scars in the uterine mucosa were interpreted by the author as healed syphilitic ulcers. This, by the way, is one of the few cases of syphilitic endo-metritis recorded in literature.

If the Wassermann or kindred test as a routine pre-operative measure becomes the standard in our hospitals, the number of such mistakes is bound to decrease, and it will depend on the critical judgment of the surgeon to establish a clear-cut indication for operative intervention. In doubtful cases, a course of specific treatment may clear up the situation.

* Amer. Journ. of Syphilis, January, 1929.

2. The number of patients with unrecognized or untreated syphilis who are subjected to operation on very good surgical indications is probably very large. Do they run any undue risk in surgery? Is their syphilis likely to lessen their chances of ultimate recovery or to interfere with the normal course of convalescence?

Theoretically an affirmative answer to the questions seems self-evident. We know that syphilitic infection causes a generalized spirillosis almost instantaneously. Senger[31] tells of the deliberate inoculation of a medical student. Nine hours afterward the lesion was carefully removed by wide dissection. Nevertheless the patient showed typical syphilis later, proving that the increase of spirochætes is tremendous and their spread through blood and lymph channels marvelously rapid.

The problem has also been studied experimentally by Brown and Pierce[5] who showed that, in rabbits, as soon as infection takes place, the spirochætes begin to multiply and invade the surrounding tissues, gaining access to both the lymphatics and the blood stream, and are widely distributed over the body even before an initial lesion can be detected.

We know, furthermore, through the researches of Warthin,[35] Barach,[3] Henry,[11] and others, that in syphilis the blood channels and the heart suffer the greatest involvement and that the heart is probably the most frequently affected organ of the body. We learn from Hoppe–Seyler[15] that syphilitic lesions of the aorta and other vessels seldom retrogress completely under specific treatment, and we are warned not to subject such patients to physical strain. Here one may again refer to Warthin,[35] who reports eight cases of sudden death due to an exacerbation of latent syphilitic myocarditis which was caused by overexertion and heat. Only in two of these eight cases was the disease recognized in life; and the relation these observations bear to the physical strain of a major operation is self-evident.

Of other vital organs, the kidneys may become acutely (Stokes[29]) or chronically (Hoppe–Seyler[15]) inflamed in syphilis. In fact, all organs and tissues of the body may be more or less affected by the disease; and the syphilitic cachexia with its resulting lack of general resistance, which we find so frequently, and more particularly in women, is by no means confined to the later stages of the disease, but is often encountered, for reasons as yet unknown, in young women who have latent syphilis.

The life insurance companies have long realized that syphilis lowers the vitality of individuals. "No man," says one of their experts (Brockbank[4]), "who has ever had syphilis can be rated as a first-class life. The mere fact of his having had syphilis at once places him in a second-class division."

Clinical evidence in the field of surgery amply confirms this attitude. In forty-one surgical cases with positive Wassermanns, Senger[31] observed non-union of fractures, gall-bladder infection associated with cirrhosis of the liver, intestinal strictures resembling cancer, etc. Repeatedly, there was disturbance in wound healing, as for instance after an operation for uterine fibroid, where no one had suspected the patient of syphilis until a gumma

developed along the line of incision. "Had the Wassermann been taken before instead of after the operation, how much suffering she would have been spared."

Similar observations are rapidly accumulating in recent literature. Coues[7] calls attention to the fact that the operative wound may take on the characteristics of a specific ulceration. Darnall,[8] Mendonça,[19] Ritch,[26] and others have observed cases in which the entire wound opened up again after as many as ten days, without any signs of infection, but healed perfectly without further mishaps after specific treatment had been instituted. Payne[24] concludes that "the surgeon can do no greater work for the industries he represents than have a Wassermann made on *all* injured patients, so that he can institute appropriate treatment to the end that the injured, the employer, and the doctor will not have a long-drawn-out treatment and convalescence".

My own observations[12] coincide closely with those quoted above. I have seen extensive suppurations of the abdominal incision resist all possible treatments for weeks, but turn into clean and vigorously granulating wounds as if by magic when antiluetic treatment was instituted. I recall five cases in which the entire abdominal incision broke open about a week after operation. The tissues of the abdominal wall showed no tendency whatever to unite, but there was no suppuration present. All five patients were profoundly cachectic. Two were probably not luetic, but two were frank syphilitics, and the fifth, despite a negative Wassermann, was most likely diseased.

In addition to increased morbidity, there may also be an increased operative mortality in syphilitic patients. To express the percentage in figures is probably impossible. The case related by Carstens[6] may serve as a suggestion. A patient with a large fibroid received antisyphilitic treatment preparatory to operation. A few days before the latter was to be performed she died quite suddenly from cerebral hæmorrhage as the autopsy revealed. Had this woman died after operation, her death would probably not have been ascribed to her syphilis. And yet I am convinced that in two cases of mine of death from surgical shock in Wassermann-test women, it was the patients' syphilis, and not the operation, which, in the last analysis, caused the fatal issue. In one of these women, in whom a vulvectomy for very extensive elephantiastic tertiary vegetations was performed, the bleeding, which as in the cases reported by Gallagher,[10] was excessive, may have been as harmful as was the narcosis.

Here, too, the case of a man of forty-one may be mentioned who was operated upon by Ritch[26] for acute suppurative appendicitis. His postoperative course was not remarkable until the seventh day when he developed a condition which was at first diagnosed as cerebral hæmorrhage with hemiplegia. A thorough physical examination was now made, and the strongly positive outcome of the Wassermann test led to the diagnosis of cerebral endarteritis of syphilitic origin, and specific treatment brought about a cure.

That a general anæsthesia with syphilis of the brain may prove fatal has been conclusively demonstrated in two cases by Le Count and Singer.[17]

The post-mortem study of the brains showed typically syphilitic histological changes. In one case the operation was commonplace, the length of the narcosis barely one hour; but investigation following death disclosed the fact that the patient had complained of severe continuous headaches for the past few years. The authors therefore demand that with symptoms or signs suggestive of alterations of any sort in the central nervous system, a thorough examination to determine a syphilitic infection should precede any elective operation. This of course would include even such ordinary symptoms as headache and dizziness.

Spinal anæsthesia is usually considered contraindicated in syphilis. Having employed it on scores of frank syphilitics without any unfavorable after-effect, I felt inclined to disregard syphilis as a contraindication. I have, however, observed two cases of cerebro-spinal meningitis after spinal anæsthesia. In both instances, post-mortem revealed the presence of tuberculosis. As syphilis and tuberculosis are so often associated, the question remains open whether spinal anæsthesia in syphilitics can stir up an old tuberculosis. Linzenmeier,[18] who observed meningitis in a syphilitic woman after spinal anæsthesia, brought about a complete cure with salvarsan.

The question of post-operative disturbances in syphilitics becomes complicated because of the fact that all of us have time and again seen perfectly smooth recoveries in individuals whose syphilis was known to us at the time of operation. Comparative statistics of syphilitics and nonsyphilitics, even if extant, would have little value on account of too many variable factors. Menninger[20] supplies post-operative statistics of twenty-two cases with four-plus Wassermann. Of these, sixteen, or 72 per cent., had more or less difficulty of wound healing, and six, or 28 per cent., had primary union. If, however, one divides the cases into those where no specific treatment was given, and those where either pre-operative or post-operative therapy or both was administered, the differences between the various groups are insignificant. This may be due to the small size of the series. Goeckerman[13] concludes from a study of the post-operative records of seventy-eight patients known to have syphilis (1) that patients with syphilis, who have been treated, can be operated upon with impunity; (2) that the patient whose infection is of long duration is on the whole a poor surgical risk, but only in proportion to the damage his tissues have sustained. He is no worse a risk than another patient with an equal amount of damage from some other cause; (3) that untreated patients but rarely (7 per cent.) develop post-operative difficulties.

With such conflicting evaluations of the influence of syphilis upon our surgical results, it is perhaps too soon to arrive at definite conclusions. In the meantime, as I have pointed out elsewhere,[12] every surgeon can help in this important question by thoroughly analyzing his operative cases in regard to positive or negative Wassermanns, the possible influence of syphilis upon the causes of death or post-operative complications, the effect of specific treatment before or after operation, etc. It would not be necessary to supply imposingly large figures. A series of thirty or more appendectomies, hernia

operations, hysterectomies, etc., on Wassermann-positive patients contrasted with an equally large series of the same kind of operation on Wassermann-negative persons would yield valuable information; and the publication of individual results would contribute to a great constructive work which would go far to clear the problem and thereby do away with much suffering and failure.

*Addendum.*—Brief mention at least should be made of syphilitic infection acquired in the course of surgical procedures. Scheuer [30] has tabulated the method of transmission in 14,590 extragenital chancres occurring from January, 1896, to January, 1909, and including all cases in which the method of transmission was known. Of particular interest to us—and not a little humiliating—is the number of patients infected by physicians which is no less than 21.92 per cent. of the total number of infections considered. There were 272 cases of infection due to vaccination and forty-six caused by infected instruments, and this points out a moral as to the necessity for scrupulous care in the disinfection of instruments.

Physicians and attendants are constantly exposed to great danger of infection from patients. Scheuer's statistics refer to 168 cases in physicians. In surgeons who are infected during an operation on a syphilitic by needles or other sharp instruments, the inoculation usually occurs direct into the circulation; in such cases there is often no initial lesion, and the disease manifests itself first by secondary lesions. For this syphilis without chancre the French term *"syphilis d'emblée"* is generally used. Almkvist [1] has written on the subject; and more recently Gaucher [11] recites the case of a surgeon who cut himself during an operation; he had no chancre on the hand where it was wounded, but developed a typical roseola six weeks later. Such examples can readily be multiplied from literature, and it is probable that many more are never published.

Gaucher also mentions the occurrence of a roseola without a previous chancre, following an intramuscular injection with a needle previously used on a syphilitic.

Another instance of surgical infection given by the same author is that of a woman who during her operation was infected in the peritoneum by an assistant who had mucous patches in his mouth.

Finally, three cases of chancre of the tonsils reported by Wigglesworth,[36] Sigwart,[32] and Baer [2] must be mentioned. All three cases concerned physicians who infected themselves by using tracheal catheters on syphilitic newborn.

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# SURGICAL TECHNIC *

## By Walter G. Elmer, M.D.

### of Philadelphia, Pa.

Perfect surgical asepsis in an operating room depends upon the nurse in charge of it. The surgeon is preoccupied with the patient and the successful outcome of the operation he is performing and it is impossible for him to give close attention to everything that goes on around him. He believes in his surgical nurse and trusts her implicitly. Otherwise she would not be there. The nurse has been taught in a more or less formal way by doctors. She has attended the lecture courses given in the hospital where she was a student nurse. But most of her practical instruction has been received from nurses older and more experienced than herself. Her mind has been trained in minute details—details which are often in themselves quite unimportant—and it may not grasp the really important things —matters so vital that they may mean the life or death of the patient. The surgeon may never have given any thought to some of these important things and they may pass unnoticed before him, or he assumes that his surgical nurse has been carefully trained and is carefully carrying out every known principle of surgical asepsis. I have discussed these questions with many operating room nurses and have never found one that was not trying to do her best in conducting her operating room in a faultless manner.

After one has spent several hours in a hospital operating room watching a series of operations, observing every detail of the work of the surgical nurse and her assistants, not only during the operation but also in the interval when she is preparing for the next one, noting the possible links in the chain by which infection could be carried from a septic case to a clean one, and then later spent a half hour or more discussing with the nurse the details of her preparation of the operating room supplies and of all the articles that may be used during the operation—he has a fairly accurate idea of the surgical asepsis which is carried out in that particular hospital, and one should be able to walk away from the hospital with the feeling that he would be perfectly willing to have some member of his immediate family operated upon in that particular operating room under the supervision of that particular nurse.

Let us consider some of the incidents which might occur in a well-conducted operating room which could readily cause a septic wound in an otherwise clean operation. The operator and his surgical nurse might be in a quandary as to the source of the infection. There is no special objection to a surgeon operating in his street clothing except insofar as it affects

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his own personal comfort, especially in the hot summer months, but our feeling is that a white duck suit and white canvas shoes are much more in keeping with the surroundings.

The following hypothetical situations suggest the ways by which infection could be carried from a septic case to a clean one:

The surgeon is performing an operation in the region of the hip—a perfectly clean surgical procedure. As he proceeds he finds the position of the patient is not satisfactory and asks to have a sand pillow placed under that side of the pelvis. A nurse goes to a nearby supply room and brings in a sand pillow and while the patient is tilted over to the opposite side she raises the sterile sheet, places the sand pillow under the side of the pelvis and allows the sheet to fall back into place. In a few moments the sheet is saturated with blood which trickles down from the wound or it gets wet from the water dripping from the surgeon's gloves after he has rinsed them in the sterile water basin. The entire field of operation must sooner or later be contaminated with whatever infectious material the sand pillow may carry. Only a few hours before or a day or two before it may have been used in an operation for osteomyelitis, the pus soaking through the sterile sheet or towels has been spread over its mackintosh cover and later dried there. In the absence of direct sunlight these organisms may remain alive for days. We assume that a nurse has wiped off the blood and pus stains but she has not sterilized the sand pillow. Or again, the surgeon is operating upon a septic abdomen or an empyæma of the thorax and the septic material runs down the patient's side and over the iron framework of the operating table. A nurse later washes the glass plates and the white enamel or nickel-plated frame of the table which has been soiled but it is hardly possible that she can sterilize it. This is followed by a clean operation and if the sterile sheet which hangs over the side of the operating table gets wet, the surgeon's gown coming in contact with it can become infected and this in turn infect his gloves.

Infection does not pass through dry sheets or towels but when these are wet the virus of septic material can penetrate quickly through the cloth and contaminate everything within the operation field.

The surgeon is about to operate upon a patient's arm and tells the nurse that he wants the arm outstretched at right angles to the body and then turns to explain to his audience what the operation is to be. Meanwhile a nurse procures a board and pushes it beneath the mattress on the operating table to provide a horizontal shelf. This is covered with a single thickness of sterile sheet, the assistant paints the limb with iodine and carefully washes it off with alcohol, the surgeon turns from his audience to find everything in readiness and proceeds with the operation. In a few moments the sheet is wet and the operation might just as well have proceeded upon the bare board.

We will next suppose that the surgeon and his assistant enter the operating room dressed in white duck suits. The nurse takes out of its

cover a sterile rubber apron which she puts on the operator. The assistant takes down a rubber apron from a hook and puts it on. This has not been sterilized and has been worn during many operations. During the progress of the operation the gown of the operator is very apt to get wet. Possibly the surgeon leans against the side of the operating table or in bending over his patient his gown comes in contact with moist towels which surround the wound—or he may find his gloves so slippery with blood that he cannot tie a ligature securely. He turns to the sterile water basin, washes his gloves and rubs them against the front of his gown to dry them—an operator may do this automatically or quite unconsciously—and proceeds to tie the ligature. The wet gown adheres to the rubber apron beneath it when the surfaces come into contact. But suppose the operation has revealed a perforated appendix lying in free pus. The surgeon's rubber apron has now become infected with a very active septic organism. In the case of the assistant, however, the situation is different. His rubber apron is not sterile. It may have been worn at a previous septic operation and if he does the same thing that his chief does he is carrying infection on his gloves directly into the wound. The operation finished, the surgeon and his assistant remove their gloves and gowns but not their rubber aprons. They go through the usual procedure of scrubbing and cleansing their hands and forearms, put on clean gowns and gloves and turn to the next patient. This one happens to be a clean hernia operation. If the first operation were a clean appendix case there is nothing about the surgeon's attire which can infect the hernia operation. But if the first operation had revealed a ruptured appendix and free pus, the rubber apron is a dangerous menace to his hernia patient as soon as his sterile gown gets wet. The rubber apron of the assistant is a menace to both patients if his gown gets wet. And there may be a sufficient number of operations on the schedule to fill up an entire forenoon or afternoon.

Meanwhile let us see what the surgical nurse is doing. She is wearing a gown with loose flowing sleeves which hang fully six inches below her forearm above the gauntlet of her glove. After each operation she removes her gloves, washes and disinfects her hands and puts on fresh gloves for the next operation, but she wears the same gown throughout the entire series of operations. The instrument tray which is placed just above the patient or within easy reach of the surgeon is covered with instruments which are being used in the operation. The nurse removes them, washes them, replaces them. Her loose sleeves are trailing back and forth over these instruments and likewise over the instruments, ligatures and sutures on her instrument table. If we should question the nurse about this afterwards she would probably tell us that no pus was encountered at any of the operations and as they were all clean surgical cases there was no need for her to change her gown. But how could the nurse possibly know this? We may have noticed that the surgeon carefully tied up the neck of each of the two or three gall-bladders which we saw removed and placed in a sterile vessel for

a laboratory examination and report on the nature of its contents. If the nurse were right in her contention, why should she change her gloves or why should the doctors change their gloves? But this same nurse is wearing a mouth-guard because she realizes that her speaking voice projects minute droplets of saliva which may carry infection to the ligature or suture which she is holding scarcely a foot away from her mouth.

Ten years ago † we attempted to point out and to emphasize the danger of infection coming through sterile sheets or towels the moment they are wet and we also attempted to point out the best way to guard against this danger. This can be done effectually and absolutely by placing sterile rubber sheeting immediately beneath the sterile sheet or towel. This rubber sheeting is cut into sizes corresponding to an ordinary towel and it is only those areas which are likely to get wet during the operation that need to be thus protected. These rubber towels can be sterilized in only one way and this fact cannot be overemphasized. After they have been washed they must be immersed beneath the surface of boiling water and boiled for five minutes. They *cannot* be sterilized in the autoclave. Live steam cannot pass through rubber. A rubber towel which has been folded several times upon itself and wrapped in a cloth cover must contain air pockets, and this also applies to rubber gloves. When these are packed into the autoclave the live steam reaches the outer surface but cannot pass through the rubber to reach the inner surface. The surfaces with which the live steam comes into contact are sterilized by moist heat but the inner surfaces, where there are air pockets, receive only dry heat sterilization. Moist heat destroys all germs and spores at boiling temperature, 212° F., in five minutes, but dry sterilization requires 350° F., for one hour to kill all germs and spores. The autoclave is operated at two atmospheres pressure or thirty pounds to the square inch for twenty minutes. That is 267° F. moist heat which is more than sufficient to kill every living organism and spore with which the steam comes in contact, but the air pockets are receiving only dry heat sterilization and both the degree of heat and time of exposure are insufficient—almost 100° below the required 350° and forty minutes short in time.

After the rubber towels and gloves have been boiled five minutes they are harmless. They can then be dried and powdered and put away in packages and later when needed can be put through the autoclave as the final step.

Suppose a surgeon uses a rubber sheet large enough to cover the patient completely and hang down over the sides and the foot of the operating table with an opening in the centre similar to the usual laparotomy sheet. If this sheet is sterile it, of course, affords ample protection. But when it becomes soiled with the pus of a septic operation, there is no way by which it can be certainly and absolutely sterilized. The autoclave cannot do it

† ANNALS OF SURGERY, vol. lxviii, p. 646, December, 1918.

and it is too large and bulky to be conveniently boiled unless it be rolled up loosely and boiled in the utensil sterilizer.

If a nurse covers her instrument table with a sterile rubber cover and over this places a sterile cloth, her instruments, ligatures, sutures, etc., are perfectly protected. However, during the progress of the operation she is frequently washing the used instruments and putting them back on the table. The cloth gets wet. At the end of the operation the cloth is removed but the rubber cover remains and perhaps we can see several small pools of water lying in its depressions. A fresh sterile cloth is spread over the table and at once we see the moisture soaking through. The instruments are then arranged on the table for the next operation. Perhaps the preceding operation was an aseptic one, but it might not have been. A fresh sterile rubber cover should be used for each operation. An easier method is to keep the instruments, sutures, ligatures, gauze sponges, etc., on white enamel trays which are sterilized in the utensil sterilizer. Two of these trays, each measuring twelve by eighteen inches, placed side by side on the instrument table are sufficient for any operation.

It is an advantage to use colored towels and sheets rather than pure white. The white coverings reflect the glare of the lights and cause the pupils to contract and this makes it more difficult for the operator to see into the depths of the cavities which must be explored. The white glare from the operating table also makes it more difficult for the visitors to see distinctly the structures revealed at the operation. I have been using dark blue, but dark green is even better for this purpose. If the operator clamps large white gauze pads to the margins of the skin incision, the advantages of using the green cloth are of course lost.

Now, finally, let us consider a single hypothetical case and attempt to analyze it. A patient in apparently good health has been advised to have a serious operation performed. He selects a surgeon in another city and enters a hospital in that city. The operation is performed as skilfully as it could be performed anywhere. The patient was in the lithotomy position and the incision was through the perineum. His temperature was normal the next morning and his condition in every way satisfactory. It was what we usually consider a clean surgical case. But by evening the patient's temperature had risen considerably and in two days reached 106° F. There was nothing about him to account for his high temperature and rapid pulse except deep infection in the wound. We could not accuse the colon bacillus in its normal state from a healthy bowel of causing a temperature of 106°. A virulent organism was at work in the deep tissues—probably the staphylococcus aureus or hæmolytic streptococcus or both. Every means that could be used to save the life of the patient was used and after a long illness he recovered. We naturally ask ourselves what could have been the cause of such a desperate illness when a normal convalescence was expected. We can, I think, dismiss the gloves, instruments, ligatures and

sutures from consideration. We have left then but two possible carriers of dangerous infection. If a Kelly pad were used, and it probably was, it may have been soiled with the septic discharge of some previous patient and although it had afterwards been washed it was still carrying the infection. The sterile sheet which had been tucked under the patient to hang down and cover the pad was soon wet with blood and wherever it adhered to the rubber pad infection could come through. Instruments such as tenaculum forceps and hæmostats hanging from the wound could become infected as well as the gloves of the operator and his assistant. The other object which we might suspect is the rubber apron which the operator is wearing beneath his gown. He is sitting on a stool as he performs the operation and his gown will almost certainly get wet. It would be most difficult for him to avoid it. If the rubber apron were not sterile, infection quickly comes through. The rest follows as a natural sequence.

We recall two cases that were published in the public press. Both were young women who insisted upon having their lower limbs straightened as they felt self-conscious on account of moderate bow-legs and short skirts. An osteotomy was done in each case. The result was most unfortunate in both instances. The first patient on the Pacific Coast had to have one leg amputated and the second patient, in the Middle West, had to have both legs amputated. We can only surmise what complications made this necessary. In the first case it might have been due to damage to the blood vessels lying on the outer surface of the tibia—the osteotome having been driven completely through the bone instead of about three-quarters of the way through and a greenstick fracture made in the outer portion. In the second case it may have been caused by infection carried into the marrow cavity by the osteotome. This seems to be the more likely explanation as this patient had a temperature of 105° before her legs were amputated. The explanation of the infection might be found in some of the suggestions which have been made in this paper.

A few days ago a special despatch to the *New York World* stated that a young woman in Paris, about to be married and eager to appear in a wedding dress with a short skirt decided that her calves were too fat to look well. She insisted on an operation to make them slender. One calf was operated upon but the foot turned black and it became necessary to amputate her leg. It hardly seems likely that the blood supply and nerve supply of the leg and foot could be so damaged by an experienced surgeon that gangrene would result. It is much more likely to have been due to infection.

Surgeons will sometimes hesitate to recommend an operation because of the danger of infection. Every surgeon takes every possible precaution to safeguard his patient against this danger. It is the unsuspected source of infection that is the most difficult to guard against.

# TRAUMATIC FACIAL PARALYSIS AND ITS SURGICAL TREATMENT BY FREE TRANSPLANTATION OF FASCIA LATA *

## By Hermann Fischer, M.D.

### of New York, N.Y.

The operative treatment of complete facial paralysis was introduced by Ballance in 1895. In applying his operation to the facial nerve he followed the method of Letiévant which this author had described as *"greffe nerveuse"* for injuries of the motor nerves of the extremities. Ballance himself was not successful in his case, but three years later Faure and Furet, who performed the operation independently of Ballance, were rewarded by a good result.

It was natural that in injuries to the peripheral nerves direct suture of the divided stumps suggested itself and when this simpler method could not be applied for some reason or other, the more complicated operation of transplanting functioning nerve fibres into the paralyzed nerve was devised. In the event of a facial paralysis direct reunion of the divided nerve is only possible along its very short course, after it emerges from the foramen in the bone to the point of division into its various branches, a distance hardly more than two inches. If the lesion of the nerve happened to be along its course in the bony canal an end-to-end suture was impossible.

The most frequent cause of facial paralysis, except in injuries by weapons and bullets, are surgical operations on the parotid, on the structures of the neck, and operations for purulent otitis media and mastoiditis. In order to reëstablish the function of the nerve it was necessary to effect an anastomosis between the peripheral stump of the facial and the central stump of some motor nerve lying in its neighborhood. Ballance, Faure and Furet have used the accessory nerve or one of its branches—the *ramus sternocleido-mastoideus* or the *ramus trapezoideus.* Koerte, in 1903, employed the hypoglossal nerve and this hypoglossal-facial anastomosis was acknowledged by most surgeons as the best method, and has been often used since then.

The results of this anastomosis have been very good in a large number of cases. The tonus of the muscles of the face was reëstablished usually after several months, the drooping angle of the mouth was straightened, the disagreeable drooling of saliva ceased and when the patient's face was at rest, his facial expression was almost normal. The lagophthalmus was influenced to a lesser degree.

The disadvantages of the operation were annoying simultaneous movements of the face when the muscle groups were moved which were supplied originally by the nerve used for the anastomosis. When the accessory nerve had been employed muscular contractions occurred in the muscles of the face

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* Read before the New York Surgical Society, November 14, 1928.

Fig. 1.—Hypoglosso-facial paralysis, before operation.



Fig. 2.—Final result obtained by facial transplantation.

whenever the upper arm or the shoulder was raised; if the hypoglossus had been used movements of the tongue caused corresponding movements in the face. At the same time, it was very difficult for the patient to move his facial muscles without also moving his arm and shoulder or his tongue. Only in very exceptional cases has the patient been able to move his facial muscles independently. A further disadvantage of nerve anastomosis is the loss of function in those muscle groups supplied by the nerve employed for the anastomosis. In cases in which the accessory nerve had been used the patient was unable to move the shoulder or arm with its full force.

After hypoglossal-facial anastomosis naturally an unilateral paralysis of the musculature of the tongue followed, which led to very disagreeable functional disturbances, especially in the first few months after the operation. The paralysis of the tongue makes speech, swallowing and eating difficult. It is true, however, that these disagreeable symptoms disappear after two to three months and the patient learns to use his tongue in the normal fashion.

The accompanying photographs (Figs. 1 and 2) show a patient before and after operation on whom, eleven years ago, I performed a hypoglossal-facial anastomosis. Two years before I saw him, this patient had suffered from a very severe and extensive septic phlegmon of the neck with secondary necrosis of the mastoid process and temporal bone, in the course of which the facial nerve along its course through the bone had been totally destroyed. The patient was, on account of the continual drooling of saliva and trickling of tears, totally incapacitated for work, and consequently was very much depressed and despondent. The operation was a very difficult one on account of the dense scar tissue. The result of the operation was cosmetically excellent, as the photographs show, but isolated innervation of the mimic muscles of the face he never attained. In a second case I had a similar good result, although in this case the paralysis had lasted over seven years. Both patients, however, complained bitterly for several months about the paralysis of their tongues.

In judging the value of the nerve anastomosis for facial paralysis, F. Kraus says: that a complete restitution of the extraordinary fine mimic movements which the normal innervation of the facial nerve produces, must never be expected. What we wish and what we accomplish with these different methods is, therefore, not the reëstablishment of the extremely differentiated facial nerve tracks, but the improvement of the disturbances which have been caused by the paralysis which not only disfigure the patient, but handicap him socially.

In those cases in which a result was not obtained, in spite of the nerve anastomosis, one has tried to improve the deformity by a muscular plastic. For this purpose a number of methods have been recommended. Gomoiu and Jianu have used a pedicle flap from the sternocleido-mastoid muscle. This was led through a subcutaneous tunnel to the commissure of the lips and anchored there by percutaneous sutures. O. Hildebrandt demonstrated before the German Surgical Congress in 1913 a case in which he had done a similar muscle plastic with great improvement. The disadvantages of this

operation are, that, with every movement of the head the angle of the mouth is pulled down. Jianu therefore, suggested instead of the sternocleido-mastoid to use a flap from the masseter muscle. Lexer has made the same proposition. The muscle flap, with its pedicle toward the zygoma, is turned toward the angle of the mouth, its free end is divided into two parts, one of which is sutured to the upper lip, the other one to the lower lip. The results were cosmetically not very brilliant.

Besides nerve anastomosis and muscle plastic operations in facial paralysis, one has tried to improve the deformity by a simple mechanical suspension of the angle of the mouth. According to Momburg, Busch has employed a loop of an aluminum-bronze wire which he fastened to the periosteum of the zygoma and which he looped sub-



Fig. 3.—Facial paralysis before operation.

cutaneously around the angle of the mouth, the wire being pulled taut until the angle of the mouth on the paralyzed side of the face was on the same level with the normal side. Momburg has performed this operation in five cases with slight modification of suspending the loop of wire from the zygoma itself. The cosmetic result was good.

In March of this year (1928) I was consulted by a young girl of eighteen who had since early infancy a complete paralysis of the left side of the face. When ten weeks old a tumor the size of a walnut was noticed at the angle of the inferior maxillary bone just below and behind the lobule of the ear. A surgeon extirpated the tumor and immediately after the operation it was noticed that a complete facial paralysis had developed. In the course of the years her paralysis improved to a certain extent, the muscle tone returned somewhat, and the lagophthalmus improved, but there was still present a considerable flattening of the whole left



Fig. 4.—Facial paralysis. Patient shown in Fig. 3 after fascial strip operation.

side of the face. The left angle of the mouth droops considerably, the left naso-labial fold is very shallow and hardly visible, and there is still a slight lagophthalmus present,

as she cannot entirely close the left eye. Since she has grown up, the young girl is very conscious of her deformity, she is psychically depressed and does not like to mix with people as she continually thinks about her crooked mouth.

The neurological examination, which was kindly done for me by Dr. Foster Kennedy, showed that a part of the facial nerve was functioning and I, therefore, decided not to
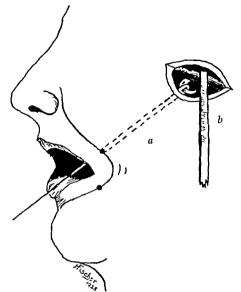


FIG. 5.—*a* Needle lying subcutaneously. *b* Fascial strip looped around zygoma.



FIG. 6.—Incision in buccal mucous membrane.

do a nerve anastomosis but to use a procedure first which would not endanger the little nerve function which she had regained; secondly, one which would not leave a visible scar and still would have the desired cosmetic effect.

I, therefore, did a free transplantation of fascia lata to improve the deformity. The operation was done on March 6, 1928, under general anæsthesia. A fascial strip, twenty centimetres in length and about two centimetres wide, was excised from the fascia lata. A small incision was then made through the skin over the zygoma and with a properly curved aneurysm needle the strip of fascia was looped around it. One end of the strip was then armed with a long straight needle which was pushed along subcutaneously towards the angle of the mouth until it reached a point on the upper lip, about one centimetre above the commissure of the lips. The cheek was then everted by an assistant and, after careful cleansing of its mucous membrane and painting it with iodine solution, the needle was pushed through the mucous membrane and the fascia strip pulled through. From the point of emergence of the fascial strip a small incision was made vertically downward through the mucous membrane to a point one centimetre below the commissure. At this point the needle was pushed through the musculature of the cheek under the skin and its point made to reappear in the small incision over the



FIG. 7.—Position of fascial strip.

zygoma. The loop of the fascial strip now took in the insertions of the *musculus zygomaticus* and the *musculus risorius* at their points of insertion at the angle of the mouth. The loop was now pulled taut until the angle of the mouth on the paralyzed side was on a level with the normal side. The two ends of fascia were then knotted together and fastened with a few chromic gut sutures to the masseteric fascia. (Figs. 5, 6, 7.) Immediately after the fascia strip had been placed a normally deep naso-labial fold appeared, but at the same time there was noticed a slight dimpling of the skin below the lower lip. This slight deformity was rectified by pushing a Cooper's scissors through the small incision in the mucous membrane of the cheek and by subcutaneously mobilizing the skin from its attachments to the deeper tissues where the dimpling was present. The small wound in the mucous membrane of the cheek was closed by a running suture of catgut and the skin incision over the zygoma was closed by a few interrupted sutures of silkworm gut. On the fourth day post-operative the skin sutures were removed. Two days later a little swelling of the wound with a slight amount of oozing of serous secretion was observed. The knot of the fascia strip had become necrotic and was lying free in the wound; this was removed and after a few days the wound had closed. At the angle of the mouth, at the point where the skin had been mobilized, a small hematoma had appeared. This, however, was absorbed after two weeks.

The result of this little operation was very gratifying. The mouth was now straight, the naso-labial fold had a normal appearance and the flattening of the cheek had disappeared. It is my conviction that this simple operation should have preference in cases of facial paralysis before the other more complicated plastic operations.

The results of the nerve-anastomosis are cosmetically not any better and have the disadvantage that it takes almost a year before an improvement can be expected and that they produce secondary disturbances which take several months to overcome. Muscular flap plastics cause visible scars in the face and are also cosmetically not very successful. At any rate this fascial strip plastic recommends itself by its simplicity and by the absence of a subsequent scar. The operation can also be done immediately after the occurrence of the paralysis if it is of traumatic origin, without in any way interfering with the recuperative powers of the injured facial nerve and at the same time the patient is saved a good deal of worry about his disfigurement.

NOTE.—After this paper went to press I ran across an article of Dr. E. Koenid, Koenigsberg in Germany, in which an identical method of fascia plastic in facial paralysis is described which was published by Kirschner in 1913 in Brun's Beitraege zur klin. Chirurgie. This publication of Kirschner has escaped my attention. The priority of the operation therefore belongs undoubtedly to Kirschner.

# WHEN AND WHEN NOT TO OPEN THE ABDOMEN IN ACUTE SURGICAL CONDITIONS*

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The most significant development of modern surgery is its comparative safety. In other words, when we undertake an operation, we do so with a degree of confidence as to the immediate result little dreamed of by our forefathers, who practically always faced the dire apparitions of suppuration and gangrene that stalked in the operating rooms of old. This comparative certainty as to immediate results, however, is not the end-all and be-all of surgery. Our main concern, next to the safety of the operation, is the removal of pathology with a minimum of traumatism so as to make for the restoration of function and the final cure of the patient.

While the prerequisite for successful therapy of any kind is a proper diagnosis, surgical treatment demands a knowledge of the physiological processes involved in a given case and their relationship with the possible immediate and remote reaction to the contemplated operative procedure. For it is a self-evident fact that disturbed function of one important organ necessarily has its more or less deleterious effects on other organs of the body. This fact emphasizes the importance, not only of surgical diagnosis and surgical physiology, but of surgical judgment, which, when applied to abdominal surgery, means knowing when and when not to open the abdomen.

Of primary decisive importance is the constitution of the individual concerned. The modern laboratory, I am glad to say, has provided us with a series of tests that have done much to add to the safety of surgery to which I have already referred. Urinalysis, kidney functional tests, liver functional tests, blood chemistry, etc., are the inevitable preliminaries of every operation except the urgent emergencies. Even in the emergency cases it is the practice in the Lankenau Clinic to have a blood urea, blood sugar, blood count and urinary examination of a catheterized specimen made at or immediately before the patient is prepared for operation. In cases where the blood sugar is high, we at once give a dose of insulin. I am insistent upon this and upon the maintenance of the bodily heat, which is best obtained by the method of Crile—diathermy. With these tests has come the necessary advance in pre-operative treatment by which an otherwise poor risk can be brought within the margins of a safe operative risk. Another contributing factor to this end is the development of local anæsthesia, including intraspinal, by which certain conditions that were at one time inoperable have now been transferred to the operable category.

Turning to the subject at hand, you will all agree that the first step is to decide whether or not a given case of abdominal disease is surgical. Without stopping to enumerate the conditions that are definitely not surgical, I should like to mention at least one about which a doubt exists; that is, visceroptosis, or splanchnoptosis, to employ the more comprehensive term. In spite of the fact that the various "pexies" that have been devised to remedy this condition have generally been relegated to the discards of surgery, I still see some patients on whom the operation has recently been done, without relief, of course, and who clamor for further surgery. These are decidedly cases in which the abdomen should not be opened. I might also include nephropexy in the list except that it occasionally does good where other means fail.

Before a positive opinion is given on the visceroptotic patient an X-ray study is usually asked for. I do not object to this except from the economic standpoint. With very few exceptions we make the diagnosis without a röntgenological study. We are satisfied with the clinical study which includes the appearance and general make-up of the patient, together with nervousness, constipation, indigestion, gaseous distention, pain or discomfort referred to the upper abdomen, frequently suspected to be a gall-bladder condition or duodenal or gastric ulcer or chronic appendix, and occasionally subjected to operation on such a suspicion. Careful physical examination will detect the low stomach, a low colon and a mobile cæcum, both of which splash on palpation, and a movable right kidney. When the transverse colon is in the pelvis, by elevating the latter to the highest point possible, the colon, as well as the sigmoid, if redundant, will ascend to the upper abdomen, where they can be made out by percussion. Or by having the patient take a dose of castor oil the night before and an enema the morning of the examination, if one prefers, by injecting the colon with air the condition is readily made out. Often the X-ray report reads: "Colon fixed in pelvis." But in the many operations we do for other conditions in the visceroptotic patient I never find the transverse colon adherent in the pelvis; on the contrary, I can always lift it out of the abdomen and casually remark: "This transverse mesocolon is so long and lax that I could easily carry it down to the patient's shoe-tops." Mild colitis is frequently present. This is enough to clinch the diagnosis, as well as to demand suitable treatment.

The treatment consists of having the patient sleep with the foot of the bed well elevated, taking properly-directed exercises and gymnastics, general massage, including the abdomen, the manipulations to be made from below upward, live in the open as much as possible, forced feeding of nutritious foods, and the adjustment of an abdominal support, by which, when in position, the fluoroscope will show the prolapsed viscera to be held up to where they normally belong.

Our more immediate concern, however, is to decide the question of timely intervention in the acute disorders of the abdomen that are definitely surgical. The decision represents one of the niceties of surgical judgment. It is a well-known fact that surgical risk today means much more than con-

sideration of the patient's heart, kidneys and lungs. These elements, as I have already indicated, are more or less controllable, so that they may be said to be extraneous. It is the intraneous conditions that demand the serious attention and tax our diagnostic acumen. Acute abdominal conditions resemble each other more or less, so that, oftentimes, opening the abdomen is the only means of determining the seat of the disorder. The important thing is to recognize that operation is demanded and to act upon that knowledge, not to watch and wait, but to look and act.

Without doubt the most common ailment in the aforementioned class is *acute appendicitis.* In spite of the voluminous literature and publicity pertaining to this subject, its mortality still remains entirely too high. In trying to place responsibility for this unsatisfactory record, it may be said to be divided between faulty diagnosis and either precipitate or procrastinating surgery. It is true, the fault does not always lie with the doctor. Oftentimes he is not called until the condition has passed the early and most favorable stage for operation. This applies particularly to children where the difference between an ordinary bellyache and acute appendicitis is not always easy to recognize. I believe, however, that the severe bellyache in the child is, in the majority of cases, appendical in origin, and, further, that recurrent attacks of acidosis can be prevented by the removal of the chronic appendix so commonly diseased, not only in children, but in adults as well. Furthermore, I need only mention that, in children particularly, the onset of pneumonia very often simulates an acute appendicitis. To open the abdomen in such cases would, of course, be serious. This alone emphasizes the importance of a careful history and painstaking care in making the physical examination. But outside of such an emergency, the element of error in diagnosis still plays too great a rôle in our mortality records. Abdominal pain, tenderness and more or less rigidity of the muscles of the lower right abdomen, nausea, vomiting, constipation or, sometimes, diarrhœa, should be enough to arouse suspicion of the nature of the disorder. The modern trend is to depend on the leukocytic count to clinch the diagnosis. As I have repeatedly said and say again, for me the degree of abdominal tenderness is much more decisive than the degree of leukocytosis. This, of course, demands experience and the light touch which is so valuable an asset to every surgeon. The degree of tenderness is the storm signal of the diseased appendix by which it clamors for relief from the impending disaster of peritonitis. To wait for a high leukocytosis often means the breaking point of the storm with relief delayed until the storm settles down. Very often, also, judgment is lulled, if not dulled, by the subsidence of the acute pain. Needless to say, that too often this means gangrene. The time to open the acute abdomen where the appendix is suspected is before peritonitis has developed. If that moment has been missed, then waiting for localization of the peritonitis, if diffused, is often the best bet. I have no patience with the doctor who boasts that he opens the abdomen no matter what the stage of peritonitis may be; in passing I may say, nor do I envy him his death rate. Localization of the peritonitis can,

with few exceptions, be brought about by regulation treatment, anatomic and physiologic rest, which is familiar to all of you.

In the average case of acute appendicitis, if seen early, there should be no doubt about the diagnosis. It is after a diffusing or diffused peritonitis is present that doubt may be injected, so that we must place our reliance mostly upon the history, since in the presence of advanced peritonitis, physical examination becomes less certain. It is in the latter type of case that immediate operation too often adds to the death toll, and is one reason why the mortality records in this disease are much too high. I want to stress this point as I know the position I take is sound, being based upon many operations performed at the most opportune time. I never make an enterostomy or high jejunostomy in these patients. We, in the Lankenau Clinic, get these patients well, with few exceptions, without one or the other of these operations.

The difficult diagnosis in early appendicitis is where the appendix holds a high position lateral to or behind the caecum and colon, or medial to the caecum, or deep in the pelvis when tenderness and rigidity, on account of the distance the appendix lies from the abdominal walls, make external examination less certain, but where rectal and vaginal examination will often materially aid in forming a correct opinion. In this connection I want to emphasize the presence of left-sided lower abdominal pain in pelvic appendicitis, often associated with irritation of or inability to empty the bladder, and requiring catheterization. I see many such cases where the diagnosis is overlooked with consequent irreparable damage. In advanced pelvic abscess in the male, it is best to open by incision carried through the anterior rectal wall, unless it can be done safely through a mid-line incision immediately above the pubic bone, a catheter having been previously passed; in the female, by incision through the vault of the vagina posterior to the cervix.

While deaths caused by acute appendicitis are primarily the result of the appendical disease itself, secondarily they are the result of peritonitis and the toxæmia which it causes. Experience, bacteriological study, autopsy *in vivo,* and post-mortem examination have taught us that peritonitis plays the most important rôle in the mortality.

The pivot around which the logical treatment of acute appendicitis revolves is not so much the appendix as it is the peritonitis. In an illustrative way, the peritonitis has been likened to a conflagration caused by a lighted match. If the match is still burning when the firemen arrive, it does not attract their attention so much as does the conflagration; therefore, their efforts are at once directed to prevent extension to the surrounding buildings. So, in the presence of an appendical conflagration, the appendix can be forgotten and attention centred upon the prevention of further extension of the peritonitis.

In acute appendicitis, in the presence of peritonitis, the pith of the question is when and when not to open the abdomen to obtain the best results and the minimum mortality. I believe that, in the absence of a forbidding

peritonitis, acute appendicitis should be operated on immediately, except in the presence of some grave constitutional condition. In the absence of contraindications, be the case ever so mild, or the patient apparently on the high road to recovery, to advise waiting for an interval or a second attack shows ignorance of the possible effects of delay, and is contributory negligence in case of death. I make this statement fully conscious of its meaning. To advise interval operation only because the patient contemplates a long visit away from home, is also a dastardly practice. In support of these utterances, I am prepared to say that the occasional operator should not be the one chosen to do the work, but the operator of vast and varied experience in dealing with the pathologic abdominal riddles, as he can best deal with any of the many complications that may be present; with this proviso, I am willing to stand back of what I have said.

In the presence of a circumscribed peritonitis, removal of the appendix with the proper technic is correct. By the proper technic, I mean that the incision should be made lateral to the point or line of greatest tenderness which indicates the position of the appendix. We should not hesitate to cut the internal oblique and transversalis muscles in a direction opposite to the course of their fibers, if this gives easier and better exposure. To operate with the view of preventing a subsequent hernia is to expose the patient to the greater and more serious risk of dissemination of infection. If the appendix lies close to the cæcum and is directed upward and outward, an extraperitoneal approach is the safest route and is easily made, when, after the overlying muscles have been cut through, the transversalis fascia, which is often œdematous and infiltrated, can readily be separated from the peritoneum and the latter exposed. At this point, palpation will often detect fluid. Hypodermic aspiration will definitely determine the character of the fluid. The peritoneum is opened in the line of the wound, the fluid, pus or puruloid material evacuated, and the cæcum and appendix exposed.

A circumscribed peritonitis is easily recognized by the presence of a limited swelling, limited rigidity, limited tenderness, circumscribed pain, and either the absence of peristalsis or hypoperistalsis as compared with the peristalsis surrounding the peritonitic area, together with resonance to light percussion, but dulness and flatness to deep percussion, and limited movement of the abdominal walls over the site of the lesion. In making the diagnosis the physical signs are of the greatest importance. A leukocytic and polynuclear count should be made as a routine measure, but in the majority of instances, I attach little importance to either. When I do consider the blood picture, I pay more attention to the polynuclear than to the leukocytic count.

In circumscribed appendical peritonitis with the abscess close to the ileocæcal junction beneath the terminal ileum and mesentery, and with the terminal ileum thickened and stiffened, having to a great degree, if not entirely, lost its contractile power, after the pus is evacuated, the appendix removed and drainage established, an ileocolostomy, or, sometimes, an

ileocecostomy, will make recovery more certain, in that it prevents obstruction immediately or later. I have done this many times with most satisfactory results.

Let us now consider diffusing peritonitis, by which is meant a spreading inflammation not involving an extensive area and differing from the circumscribed variety in that it is not limited. In the diffusing peritonitis, there is both peritoneal irritation and peritoneal inflammation, the former being the forerunner of the latter. You may regard this as a distinction without a difference, but I hope to show you that it is not. Diffusing peritonitis differs from circumscribed peritonitis in that although the patient looks sicker, he does not have the peritoneal facies. The pain is more pronounced and is referred over a greater surface; there is a much larger area of rigidity and tenderness, peristaltic sounds are either absent or very feeble, or peristalsis is aggravated around the inflamed area corresponding to the area of peritoneal irritation, and abdominal breathing is more limited than in circumscribed peritonitis. Diffusing peritonitis is definitely recognizable by the careful observation of these physical signs. Time and again I have demonstrated this to my classes and subsequently proved it at operation by the presence of inflammatory adhesions, adherent coils of bowel and adherent omentum occupying the area mapped out as the site of the inflammation when examining the case before the peritonitis had subsided. Cases of diffusing or spreading appendical peritonitis presenting rigidity should be operated upon in that stage, as thus the spread of the peritonitis will be prevented. But unless operated upon at that opportune time operation should be postponed until the subsidence partial or entire of the peritoneal inflammation, which, in the experience of the Lankenau Clinic, practically always takes place if strict anatomic and physiologic rest, "regulation," as we call it, is carried out.

Diffused appendical peritonitis, in its early stage, presents a picture familiar to us all, with its general rigidity of the anterior abdominal walls, tenderness corresponding to the area of rigidity, absence of abdominal breathing, the peritoneal facies, rapid, tense and often bounding pulse, comparatively high temperature, and exaggerated peristalsis. The blood picture shows 18,000 to 20,000 leukocytes, and eighty-five to ninety-five polynuclears, the latter varying with the type of infection. Twenty to forty hours after onset of the peritoneal inflammation, or earlier if the patient has been purged, the picture changes to one of general abdominal distention, the rigidity being much less pronounced, tenderness not nearly so decided, entire absence of peristalsis, later followed by tinkling, and, finally, a silent belly, an ominous sign, when only the pulsation of the abdominal aorta is heard louder than normal, and a rapid pulse, with diminished volume; more pronounced peritoneal facies, a blood picture of moderate or low leukocytosis, but high polynuclear count, diminished output of urine that shows albumin, hyaline and granular casts, relaxed skin that later is sweaty and cyanotic, vomiting or regurgitation of dark vomitus, often foul-smelling, and restlessness, and an active brain. This presents what is usually considered a hopeless propo-

sition, but not necessarily so, if the treatment already described is carried out early and to the letter. I have seen recovery with local abscess formation, the simple evacuation of which was followed by convalescence. When much of the active peritoneal inflammation has subsided, but has left multiple foci of pus, the patient dies of toxæmia. When the peritoneal inflammation has only partially subsided and has left a large collection, involving the pelvis and the lower abdomen, the patient may, sometimes, by instituting drainage alone, get well. These are cases in which puncture through the rectum or the vaginal vault has occasionally proved successful.

A condition that requires keen diagnostic and surgical judgment is *acute intestinal obstruction*. There is, perhaps, no acute disorder in which waiting for the fully-developed clinical picture is more disastrous; in other words, refinement of diagnosis may bring no other satisfaction than to be able to say at the autopsy: "I told you so," which, of course, does the patient no good.

One important aid to diagnosis in this condition, naturally, is the history of a previous operation, for, as you all know, post-operative intestinal obstruction may occur at any time, immediate or remote, after an operation. The condition requires quick judgment and quick action. In the presence of an abdominal scar, the result of a previous abdominal operation, in a patient suddenly stricken with acute intermittent abdominal pain, one should first think of intestinal obstruction. Its usual characteristics are: Sudden onset of intermittent colicky pain, persistent vomiting, normal pulse rate and usually normal, but sometimes slightly subnormal temperature, contraction of the affected bowel, as evidenced by early stormy peristalsis with visible coils, and later, faint tingling or absent peristalsis, and meteorism. Of course, when the vomitus becomes stercoraceous, the diagnosis is evident. The thing is to obviate this latter and usually fatal stage.

Besides the information given by percussion and auscultation of the belly, the contour of the walls should be observed. Asymmetry, together with an area of intestine which, in spite of tympany, is more resistant than elsewhere, should suggest ileus, and a distended bowel and a silent belly mean either severe intestinal paralysis or peritonitis. Added to the picture in the late stage are the subjective symptoms of rapid, weak pulse, shallow breathing, anuria, and the anxious facies. The differentiation between the various forms of obstruction is not of moment. Of most moment, is to get into the abdomen as early as possible and to get out as soon as possible.

In acute obstruction following a previous operation, or in cases of obstruction at the foramen of Winslow, or a tear in the mesentery, the patient will often point to the site of the obstruction as the primary location of the pain. This item should not be lightly dismissed by the doctor as of no importance, for it often proves a valuable guide.

In passing, it may be said that *volvulus*, usually of a redundant sigmoid, is the form of obstruction that differs from ordinary acute obstruction, in that the abdomen becomes greatly distended almost immediately following

the sudden onset of intense acute pain. This should suggest the form of obstruction in question and, needless to add, opening the abdomen at once on account of the early appearance of gangrene which too often means fatality. Incidentally, upon opening the abdomen in this type of obstruction before gangrene has occurred, it is my practice, after reducing the volvulus, to anastomose the proximal and distal limbs at their roots. This is a safe procedure if skilfully and carefully done, and provides not only an uninterrupted recovery, but prevents recurrence. I have done this a number of times with gratifying results.

In children *intussusception* should be thought of in connection with the above-named train of symptoms, plus bloody and mucous stools, and, usually, the presence of a tumor on abdominal or rectal examination; the latter should be made in all cases of obstruction. In intussusception, the paroxysms of pain occur at frequent intervals. These cases demand immediate operation; any delay may, and usually does, prove fatal. Medical treatment and rectal injections with the hope of relieving the intussusception should not be countenanced.

Of the acute diseases of the lower abdomen, the appendix excepted, those of the pelvis are the ones that most frequently arouse the question of when to operate and when not to operate.

In general, it may be said that *acute puerperal infection* had best be treated symptomatically by anatomic and physiologic rest, unless drainage is indicated, although a residual lesion may later require intervention. *Acute salpingitis*, especially in the unmarried female, and, also, when due to gonorrhœal infection, likewise does better under expectant treatment unless, of course, complications occur. Many claims are now being made for the value of the sedimentation test in acute pelvic conditions as of material assistance in determining the opportune time for operation, as well as the prognosis in pelvic infections, to which I strongly subscribe.

The abdomen should be opened at the earliest possible time in cases of *ovarian tumor*, or a *uterine fibroid twisted on its pedicle;* or *bleeding caused by a ruptured cyst of the ovary* (I have known the last-named to occur at the menstrual time where the patient had been dancing the greater part of the evening) ; *ruptured ectopic pregnancy, placenta prævia, accidental hæmorrhage in the pregnant woman, ruptured uterus,* and *perforation of the uterus,* accidental or otherwise.

*In a chronic pyosalpinx,* the result of a gonococcic peritonitis or a post-puerperal infection operation is indicated, while the early cases should positively not be operated. These patients, in my experience, if treated by masterly inactivity, recover, as a rule, without mechanical interference.

In a limited number of *post-puerperal abscess* cases, evacuation through the extraperitoneal approach, above the lateral half of Poupart's ligament, is best.

There is no class of case in which surgical judgment can be better displayed than in this one. The post-puerperal infection that does not subside,

but goes on to pus formation, should be operated by the extraperitoneal approach above the outer half of Poupart's ligament, carrying the incision well lateralward, or by incision into the culdesac through the vagina. In passing, let me say that in our clinic, where we see so many cases of late abortion, we do not practice curettage when there is temperature or any signs of peritonitis, or of peritoneal irritation. Anatomic and physiologic rest, carried out in its entirety, will give the desired result. Without wishing to rap the young general surgeon or the young obstetrical surgeon, I beg to say he should stop, look and listen. Did time permit, I am sure I could carry this discussion far along with benefit to some, at least.

Retroperitoneal lymphangitis of the right lower abdomen, giving rise to tenderness and rigidity, is not unlike the picture of an appendical inflammation, but is attended by higher temperature and pulse-rate, depending upon the particular organism responsible for the condition. For example, the staphylococcus albus carries an hemolytic infection with most pronounced constitutional reaction. Blood smears will show as high as 800 colonies to the microscopic field. A persistent high temperature with corresponding depression of the patient should at once excite suspicion.

In my opinion, these cases are usually fatal, do what you will. I have seen a number, practically all of which have ended fatally. They result, usually, from an abrasion which, if cultured early, shows the staphylococcus albus. The local diagnosis is made by the presence of enlarged inguinal glands of the affected side and of the glands in the pelvis, immediately above Poupart's ligament. This, together with constitutional symptoms that seem out of proportion to the local findings, makes the diagnosis, and indicates that the abdomen should not be opened.

The abdomen should be opened in the early case of *perforated diverticulitis of the sigmoid*. In the late case of sigmoidal diverticulitis, and active peritonitis, it is better not to operate until there is positive localization, and preferably not until abscess formation. When the latter has taken place, the extraperitoneal approach is preferable. Many of these cases have perished from too early operation.

Turning to the upper abdomen, the most frequent cause of acute symptoms is an *inflammation of the gall-bladder*. Such an inflammation, if ultra-acute, whether phlegmonous, perforative, or gangrenous, demands immediate operation as soon as the diagnosis is made. The acute, especially the non-calculous inflammation, on the other hand, which is more common than the ultra-acute, with very few exceptions should not be operated upon until the active stage has passed, since the attack will subside under proper treatment—anatomic and physiologic rest. The thing to do is, first, to give morphia to relieve the pain; secondly, wash out the stomach; thirdly, apply ice to the painful area and start proctoclysis, using normal salt solution; fourthly, withhold all water or nourishment by mouth until peristalsis is heard or the patient passes gas. If this treatment is carried out to the letter, the attack will subside, after which the case can be studied and the best time selected

for opening the abdomen. To treat these patients by medication, such as calomel, phosphate of soda, etc., is not only a mistake, but prolongs the inflammation as well as favors complications, pericholecystic adhesions, etc. Medication or food by mouth excites gastric peristalsis and favors extension of the inflammation. I see this so often where insistence upon medical treatment has apparently won the day. On the other hand, the young or inexperienced surgeon is tempted to operate on these patients at once, a practice that will not give the best results. As I have already said the diagnosis is the guide, the deciding point as to when and when not to open the abdomen.

At the onset of the attack of simple acute cholecystitis it may not be possible to differentiate between the inflammation of an early acute, high-lying appendix and that of a gall-bladder, the pain in both being referred to the epigastrium, while the muscular resistance, due to the intraperitoneal irritation, or to a peritonitis with corresponding tenderness, renders palpation most unsatisfactory. We often meet this embarrassing situation, but after a few hours of the treatment already referred to, the intraperitoneal irritation will have diminished sufficiently to make the muscles overlying the inflamed area more flexible, so that the tips of the fingers can be carried deep enough to locate the point of greatest tenderness and perhaps feel the fundus of the gall-bladder by having the patient breathe rather deeply, but slowly, when it will be felt moving with respiration. This makes the diagnosis certain. In an appendicitis the line of tenderness will be in the line of the position of the appendix. In addition to these physical findings, the history is of most importance. In the case of one or the other of the ultra-acute varieties of cholecystitis, it must be remembered that acute perforation at the base of a high-lying appendix, acute perforated ulcer, acute intestinal obstruction, and acute pancreatitis enter the diagnostic picture.

In *subacute perforated peptic ulcer,* which is most often duodenal, the abdomen should *not* be immediately opened, and why not? First, this type of lesion is, in most instances, difficult to diagnose as it is not usually seen by the surgeon until two or three days, perhaps more, after its occurrence. Secondly, it is usually taken care of by a protective peritonitis, during the active stage of which operation has more hazards than if made when the peritonitis has subsided and the peritoneal cavity is well protected; in other words, coffer-dammed. In this latter stage particularly, a posterior gastroenterostomy can be safely made without in any way disturbing the site of the lesion. These are not emergency cases, unless seen immediately after the perforation has taken place, when the diagnosis is not certain. Two possibilities, chiefly, confuse the situation—simple acute cholecystitis and acute terminal inflammation of a high-lying appendix, either of which, as in the case of ulcer, will subside if treated by anatomic and physiologic rest.

In instituting anatomic and physiologic rest, the usual procedure is to, first, wash out the stomach, but in the questionable ulcer case this had better not be done, for fear of increasing duodenal extravasation. If there is disturbing nausea, the introduction into the stomach only and retention of a

duodenal tube, drainage of the stomach contents will be of advantage and relieve the nausea. Aspirating the tube with a syringe will quickly empty the stomach. The contents of the duodenum at first are usually sterile. Later, however, from regurgitation of the contents of the upper small intestine, smear examination will show the presence of organisms of the colon bacillus group. This is the chief reason for early as against late operation in acute perforated ulcer.

A common abdominal catastrophe is *acute perforated peptic ulcer,* which, when once seen, can scarcely be forgotten, and when seen for the first time, unless the patient volunteers and gives a very typical history of ulcer, is more often than not misjudged. I see this beautifully exemplified in our clinic when the new interne comes on service, who, after he sees his first case of ruptured ulcer, rarely fails to recognize it. It is the exception for me to have to make the diagnosis, for it is already made when I am called by 'phone or the case comes in while I am in the hospital. The message is: "A perforated ulcer has been admitted."

The diagnosis is made by the history, if one can be elicited, and when this is not obtainable, by the sudden onset of acute abdominal pain making its appearance like lightning out of a clear sky, immediately followed by board-like rigidity of the abdominal walls that are tender, but not impressionable to touch. These patients maintain a more or less fixed position in bed, hoping by doing so that they will suffer less. This is a sign of moment. They are not shocked unless it is immediately after the occurrence of the perforation, before they reach the clinic, or before they are seen by the surgeon. They have a normal pulse and temperature, a dry skin, and a leukocytosis, an example of kindly nature which we are glad to see. As it is the family doctor who first sees the patient, it behooves him to be conversant with the lay of the land, and not to defer calling in the experienced surgeon at once, not this afternoon, this evening, or, perhaps, tomorrow, but immediately. It matters not whether the perforating ulcer is duodenal, gastric, or marginal, *there is only one road to the goal, and that is the operative route.* These patients should not die. All, barring a very few cases, will get well if operated within the first few hours, while they all will die if operated too late.

Why is this condition not recognized early? Because of the want of knowledge of the significance of muscular rigidity. Pronounced abdominal muscular rigidity is one of the easiest of the danger signals to read. I make this statement without fear of contradiction; except in the highly neurotic, hysterical individual it always means intraperitoneal irritation, the forerunner of peritonitis, whether caused by disease or by trauma. It is when these patients are not seen until late and there is a diffuse peritonitis with distention and the history is negative, that diagnosis is doubtful. In the majority of these cases there is a history of digestive trouble, consisting of pain one and a half to two hours after eating, which has been treated medically and

pronounced cured. I know of many such cases, since it has been my privilege to have operated on more than two hundred acute perforated ulcers.

In the presence of a central upper abdominal swelling with overlying rigidity and exquisite tenderness occurring suddenly, particularly in an obese subject past middle life, who, besides being shocked, is more or less livid, with a small, rapid pulse, persistent retching, or vomiting, *acute pancreatitis* should be thought of, and the abdomen should be opened. This condition cannot be operated too early, but too late. Medication is absolutely useless. If, under these conditions, the abdomen is opened and nothing found, no harm results, while if too much is found, death results.

A condition with as dramatic an onset, but much less frequent than perforating peptic ulcer, is *mesenteric thrombosis*. It should be thought of in the following circumstances: Onset of most agonizing acute abdominal pain in a person past middle life with high blood pressure and sclerotic vessels. With few exceptions, the diagnosis is not possible without opening the abdomen, because of other conditions, such as torsion of the great omentum, acute intestinal obstruction occurring at the site of the foramen of Winslow, or through a congenital opening in the mesentery, or in one of the peritoneal fossæ. The last named, as a rule, occurs more often in young subjects. However, this matters little, as any of them constitutes an abdominal catastrophe and calls for immediate operation, otherwise the patient has no chance whatever to recover. These patients are all shocked, but this is no excuse for not immediately opening the abdomen. The indication for operation is vital on account of the rapidly oncoming gangrene and toxæmia. Those of us who have had experience in dealing with these conditions know too well the importance of immediate action. The gravity of the situation is extreme and does not permit of deliberation if the right thing is to be done.

To repeat, the outstanding points in these cases are: A person previously well, suddenly seized with most intense abdominal pain, immediately followed by depression, especially evident in the thrombotic patient, and diffused rigidity of the abdominal walls, which are extremely tender to the lightest touch. This syndrome is enough to warrant immediate intervention. Auscultation reveals stormy peristalsis early in the case, but later, when peritonitis is advancing, if it has not already advanced, peristalsis will be either diminished or entirely absent. A silent belly is ominous and too often spells death. Very early the pain is intermittent and paroxysmal, but later it becomes continuous, while lessening of the muscular rigidity and distention shows that the demon toxæmia is on the scene and dominates the situation, which means fatality.

Acute obstruction through a congenital rent in the mesentery is likely to follow heavy lifting and cannot be differentiated from torsion and strangulation of the great omentum *en masse*. I would also call attention to strangulation of a small portion of the great omentum, the diagnosis of which is impossible. Both of the latter conditions necessitate immediate abdominal incision.

Continuance of symptoms of obstruction following the reduction of what seems to be an incarcerated or a strangulated hernia indicates the immediate opening of the abdomen.

All of these possibilities, if kept in mind when approaching the victim of an acute abdominal seizure, will reduce the serious likelihood of error. Doctor Agnew said to me not long before his death, that if he could live twenty-five years longer—he had been practicing surgery for over fifty years—how much more good he could be to the surgically sick. Personally I feel as Agnew, my revered teacher, did. Surgical intuition or judgment, the greater part of which is horse-sense, counts for most. My father used to tell me when his patients were very ill and giving him great thought, he would go away for two or three days, when he would return home to find them better. I hope to transmit this thought to my son, now a member of the interne staff of our clinic.

In conclusion, I wish to refer to a few of the traumatic conditions in which the abdomen should be immediately opened, namely, *rupture of the liver, the spleen, the pancreas, the small intestine, and the bladder*. The severity of the symptoms and physical signs in these cases depend upon the extent of the injury. When the injury is slight, the evidence of shock, hæmorrhage and muscular rigidity is not so pronounced as in reverse conditions; however, the sign always present is muscular rigidity caused by intraperitoneal irritation. This alone justifies the immediate opening of the abdomen. In the presence of definite muscular rigidity if we act at once, and discountenance waiting and watching, we'll have no regrets but much joy. If I could know that you carry this away with you I should feel happy I came, for I have told you something.

To treat the patient for shock, to make a blood count, to observe the pulse, to infuse only to allow the infusion to escape through the torn vessels, is to court danger. The death rate in these conditions is much, much too high, and, I am sure, is due to dillydallying and not being sure of oneself. A recent case admitted to our clinic illustrates the importance of the presence of muscular rigidity immediately following severe trauma of the abdominal walls and of interpreting it as a danger signal.

No. 2572/28. A male, aged thirty-eight years, was admitted to the Lankenau Hospital September 20, 1928. While planing a board a machine struck the board which in turn struck the patient across the upper abdomen, causing a red streak at the site of the injury. This was followed soon after by epigastric pain which grew progressively worse as the patient was on his way to the hospital, about fifty miles distant from his home. On admission, September 20, 1928, he appeared much shocked, and there was marked abdominal rigidity.

Examination of the abdomen showed a line of abrasion across the upper abdomen, board-like muscular rigidity, and very marked pressure tenderness, so great that the patient could not stand the weight of the bedclothes. The blow apparently had struck him just over the site of the liver. Temperature, pulse and respiration were normal. Red blood cells and hæmoglobin normal. White blood cells 20,200, neutrophiles 76, lymphocytes 18, large mononuclears 5, transitionals 1. A diagnosis of ruptured liver was made and immediate operation was decided upon and agreed to by the patient.

Under spinocain anæsthesia I opened the abdomen through a right rectus incision. There was an immediate discharge of blood. An L-shaped rupture was found on the right lobe of the liver, anteriorly. This was sutured. Another rupture was found on the under surface of the liver, medial to the gall-bladder and running into the gall-bladder fossa. This necessitated a cholecystectomy. I also took out his appendix. Recovery was prompt and uninterrupted. Smears taken from a pool of blood in the subhepatic fossa were negative, proving that the traumatized field was sterile. Waiting in this case would have meant severe bleeding, primary anæmia, with the great risk of colon bacillus infection, and peritonitis and lessened chances of recovery by later operation.

This, as well as other cases operated promptly in the clinic, proves the correctness of our stand in the presence of marked rigidity, pain, etc. The citation of one other case, and I am done.

A boy, twelve years old, playing in the street, was knocked down by a passing wagon, the rear wheel of which passed over the abdomen. Fortunately, the accident occurred close to the hospital, so that only a short time elapsed between the receipt of the injury and admission to the clinic. There was pronounced pain and pronounced rigidity of the walls of the abdomen. I advised immediate operation, but the parents objected to this until their family doctor could be called. I waited for the arrival of the doctor, whom, fortunately, I knew very well, and whom I had no trouble in convincing that a serious intra-abdominal condition existed. I opened the abdomen, found the small intestines completely divided transversely, entailing an end-to-end union. Convalescence was rapid and uninterrupted.

The pronounced muscular rigidity forced me to take the stand I did. This holds good in all serious intra-abdominal catastrophies if the patient is seen early before the occurrence of an advanced peritonitis, or before he has been almost exsanguinated. There, I say look and act, do not watch and wait.

## CONCLUSIONS

### Do Not Open the Abdomen for

Visceroptosis.
Diffused peritonitis until (by anatomic and physiologic test) localization sets in.
Retroperitoneal lymphangitis, of the lower right abdomen.

Acute puerperal infection.
Acute simple cholecystitis.
Subacute perforated ulcer.
Late sigmoidal diverticulitis.

### Open the Abdomen for

Acute appendicitis before peritonitis sets in; or in the absence of a forbidding peritonitis.
Acute intestinal obstruction, including volvulus, intussusception, obstruction at the foramen of Winslow, through a congenital hole in the mesentery or in a peritoneal fossa.
Mesenteric thrombosis.
Torsion of the great omentum.
Ruptured ectopic pregnancy.
Ovarian tumor or uterine fibroid twisted on its pedicle.

Ruptured ovarian blood cyst.
Placenta prævia.
Accidental hæmorrhage in the pregnant uterus.
Ruptured uterus.
Perforated uterus.
Chronic pyosalpinx—gonorrhœal or post-puerperal.
Hernia, incarcerated or strangulated.
Ultra-acute cholecystitis.
Acute perforated peptic ulcer.
Acute pancreatitis.
Traumatic abdomen.

# THE TREATMENT OF INTESTINAL OBSTRUCTION

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Recent studies in intestinal obstruction have established the fact that there occurs in pyloric and high obstruction of the small bowel characteristic changes in the blood and urine chemistry.[1] These findings have led to a better understanding of the pathology of this disease and have contributed a valuable adjunct to its therapy.

In 1913 D. P. D. Wilkie[2] emphasized the importance of recognizing two different types of intestinal obstruction. These he designated as simple obstruction and obstruction plus interference with blood supply. The work of Hausler and Foster[3] and Gatch and his co-workers[4] further emphasize the importance of these two types when considering the proper surgical treatment. It is, of course, obvious that different problems are involved in the two conditions. In the latter there exists the toxæmia of infection and tissue necrosis associated with gangrene of the bowel in addition to the obstruction. Gatch, Trusler and Ayers[5] have recognized the importance of gaseous distention and have concluded that this distention alone may exert sufficient pressure to produce gangrene by occlusion of the circulation in the bowel wall, especially along the antimesenteric surface.

From these observations it is readily understood that intestinal obstruction cannot be rationally treated without some knowledge of its chemistry and pathology.

A discussion of the treatment of acute intestinal obstruction may well be divided into five parts, a recognition of which is essential for proper therapy. They are as follows:

1. Removal of the mechanical obstruction. 2. Relief of dehydration. 3. Relief of hypochloræmia. 4. Relief of starvation. 5. Drainage of the small bowel (enterostomy).

The importance of early diagnosis and surgical treatment of this condition has been emphasized since the subject first attracted the attention of medical writers. If recognized sufficiently early before alteration in the chemistry of the tissues and fluids, operation for the direct relief of the obstruction or strangulation will undoubtedly result in the cure of a high percentage of cases. Unfortunately, many cases are not diagnosed early and present themselves for treatment with the disease far advanced and much damage already done. It is this class of patients which require the utmost care in the choice of treatment. Each individual case must be carefully studied and a time selected for operation which will give the greatest chance of recovery. Almost all surgical textbooks state that operation should be

done as soon as a diagnosis is made. This is undoubtedly dangerous teaching. To operate upon any patient to relieve a mechanical obstruction of the small intestine without taking into consideration the phases of treatment as listed is to treat the disease without understanding. The time for surgical relief of an obstruction is very variable and must depend upon the patient's condition. It may, with good judgment, be done only after the patient has received large quantities of water, salt and glucose to relieve the dehydration, hypochloræmia and starvation. To rush a patient to the operating room from the ambulance for a major operation is never justifiable when two or three hours of treatment will improve the risk.

Dehydration soon becomes extreme if the small intestine is obstructed. It has been estimated that in each twenty-four hours there is a normal secretion into the upper intestinal tract of gastric juice, bile, succus entericus and pancreatic juice amounting to from seven to nine litres. Dragstedt [6] believes that these secretions are stimulated and increased by bowel obstruction. Wangensteen and Chunn [7] report a case in which the measured liquid from the stomach and duodenum amounted to 6,000 cubic centimetres in twenty-four hours. Compared with the average intake of liquid, which is less than half this quantity, the loss is of great significance. Hartwell and Hoguet [8] expressed the belief in 1912 that death in simple obstruction of the intestine is due to dehydration. Wilkie [2] also believes that the cause of death is dehydration. Gamble and McIver [9] recognize the importance of water loss, but believe that the accompanying loss of the electrolytes, sodium and chlorine to be of greater significance. Hausler and Foster [3] attribute death to starvation in uncomplicated cases. Gatch and his associates [4] go a step farther and state that their investigations have led them to the conclusion that in simple obstruction of the intestine, without gangrene, there is no absorption of toxins sufficient to cause death, but death is due to dehydration, loss of chlorides by vomiting and starvation. The majority of authors in the past have attributed death to a toxin or toxins formed in the contents or wall of the obstructed gut. If dehydration, hypochloræmia and starvation are the only lethal factors, it is difficult to explain the rapid improvement following the drainage of the obstructed gut by enterostomy. Whether or not there is absorption of toxins from the obstructed and damaged gut is a problem for future researches to determine. At present one hardly seems justified in believing that the cause of death in acute intestinal obstruction has been proven.

With a knowledge of the fluid loss as indicated above it is easy to estimate the quantity of water necessary to recover water balance. During the acute illness no less than four to six litres of liquid should be given every twenty-four hours. In extreme cases this should be increased. No harm can be done if water is given as long as thirst exists.

Water should always be given as salt solution. We have found that distilled water given subcutaneously or through an enterostomy opening below the obstruction not only does not prolong but probably shortens life. This observation has recently been confirmed by Gatch, Trusler and Ayers.[10]

Without salt there can be no life. In the hypochloræmia of intestinal obstruction the administration of sodium chloride is an essential part of the treatment. The blood chlorides, estimated as sodium chloride, may be reduced as low or even lower than half the normal. As the disease develops there is a rise in the urea and non-protein nitrogen of the blood and usually a rise in the carbon dioxide combining power. Sodium chloride, given as salt solution, tends to restore the chemical changes of the blood to normal. Just what action sodium chloride has is problematical. We [11] early suggested that it might have a specific detoxicating action, but in the light of more recent work of others this explanation is doubtful. It is probable that the salt is necessary for the proper maintenance of water distribution and water balance of the body. Many other salts have been tried but none has been found that will replace sodium chloride in the reëstablishment of normal blood chemistry.

In order to properly treat the hypochloræmia it is necessary to administer sufficient salt to return the blood chlorides to normal. This quantity, of course, varies with different patients and should properly be governed by frequent blood studies.

Before any operation is done every patient seriously ill with intestinal obstruction should be given preliminary treatment with salt solution. By using hypodermoclysis and intravenous injection three to four litres of water and fifty to seventy-five grams of sodium chloride may be given in two to four hours. Salt solution may be given safely in 2 per cent. solution under the skin and 5 per cent. in the vein if given very slowly. We recommend that about one hour be taken to administer intravenously 500 c.c. of a 5 per cent. solution. The delay in time necessary for this treatment is justifiable since it surely makes a better operative risk. After operation salt solution should be continued until the patient is out of danger. Usually four to six litres will be sufficient each twenty-four hours. It would seem logical to continue giving water and salt as long as the patient is thirsty and until the chlorides of the blood are within normal limits.

In those cases complicated by disturbed circulation and gangrene early operation is, of course, imperative to relieve strangulation or remove necrotic tissue. In such cases sodium chloride solution should be given in the same large quantities. Salt solution does not, however, have the same specific effect that it has in simple obstruction.

The need of food to furnish energy becomes an important factor after the patient has been ill for several days. It is advisable to begin the intravenous administration of glucose early in the disease and continue until the patient can take food by mouth. It may be given slowly in 10 to 25 per cent. solution. Experiments have shown that man can utilize from 0.8 to 0.9 grams of glucose per kilo of body weight per hour. This means that a patient weighing seventy kilos (154 pounds) could assimilate 56 to 63 grams of glucose per hour, furnishing about 200 to 250 calories of energy. Sufficient glucose may easily be given in twenty-four hours to produce 1,500 to 2,000 calories without harmful effect. The number of calories required for a

seventy-kilo patient (154 pounds) at rest (asleep) is 1,680, which is equivalent to the basal heat production, or the smallest energy output compatible with health.

There is some difference of opinion in regard to the value of enterostomy in the treatment of acute intestinal obstruction. Victor Bonney,[12] McKinnon,[13] Lee and Downs,[14] Walker,[15] Taylor,[16] Wilkie,[17] and C. H. Mayo [18] all write convincingly of the value of jejunostomy. From the experimental evidence available, high jejunostomy is not done without danger. We [19] have shown that simple drainage of the jejunum of the dog twelve inches below the ligament of Treitz will result in death in two to five days, with changes in the blood chemistry similar to those found in obstruction at the same level. Dogs may live indefinitely with drainage of the lower ileum. It is difficult to refute the clinical evidence in favor of high jejunostomy and further careful observation must be made to establish its true status. Enterostomy lower in the small bowel is of undoubted value in properly selected cases. Prompt relief from pain, nausea and a sense of oppression is often noted by the patient soon after the bowel is drained. A small percentage of cases will obtain complete relief in a few days; their bowels will begin to move and no further surgery will be necessary. Proper drainage of the gut will usually result if an upper left rectus incision is made and the first portion of small gut presenting is drained. Water and salt should, of course, be given in sufficient quantity in addition to the enterostomy.

The suggestion of Williams [20] that the toxæmia of intestinal obstruction may be due to the gas bacillus of Welch is an interesting observation. He concluded that beneficial results were obtained by treatment with specific serum for this disease. Further observation and experimentation will be necessary before a true estimate of Williams' contention can be made. ·

The value of human bile injected into the rectum as suggested by Brockman [21] is also subject to proof.

### CONCLUSIONS

1. From the operative standpoint obstruction of the small bowel may be divided into early and late simple obstruction and obstruction associated with circulatory disturbance or gangrene. In the early cases of simple obstruction immediate operation can be done with safety. In the late cases of simple obstruction operation should never be done without preliminary treatment of the dehydration and hypochloræmia. In cases complicated by strangulation of the gut or gangrene early operation is imperative, but may with great benefit be preceded by salt solution treatment.

2. Dehydration and hypochloræmia play major rôles in death due to intestinal obstruction. In every case sufficient salt solution should be given as rapidly as possible to correct these two conditions.

3. Distilled water should never be used alone. Experimental evidence has shown it to be not only useless but dangerous when introduced in large quantities under the skin or by enterostomy opening.

4. Intravenous administration of glucose in 10 to 25 per cent. solution is of great value in furnishing energy. It may be given with the salt solution.

5. Enterostomy as a preliminary operative treatment is of undoubted value in selected cases. It should not be depended upon to the exclusion of water and salt.

6. Treatment of intestinal obstruction with Welch bacillus antitoxin or human bile by rectum requires further investigation to establish its value.

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# AN ANATOMICAL AND CLINICAL STUDY OF INFECTIONS OF THE HAND

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The substance of this article is the result of injections of eighty-four hands in the anatomical laboratory with ten per cent. gelatin to which had been added a few cubic centimetres of formalin. To this has been added the clinical experience of the writer. Particular emphasis has been placed upon the spaces around the lumbrical and interossei muscles. Naturally, like other studies of infections on the hand, the stimulus has been the work of Kanavel.

An attempt has been made in the succeeding illustrations to give a clear anatomical conception of where and how these major infections take place, and with this knowledge it is possible to better diagnose, prognosticate and treat the various infections.

It is important to get the point of entrance of the infection since then there is a possibility and probability that the course and spread of the infection may be determined. Too much emphasis cannot be placed upon the examination of each finger and area of the hand carefully and separately.

In a thenar space infection there is tenderness over the area of the thenar space. This area is usually distended on the palmar surface and usually on the dorsal aspect of the web between the thumb and index finger. Extension of the index finger usually results in pain.

Mid-palmar space infection gives tenderness over this area with or without loss of concavity of the palm. There is pain on extension of the middle, ring and usually the little finger.

Infection of the short tendon sheaths of the index, ring, and middle fingers results in a diffuse swelling and redness of that digit with tenderness limited to the anatomical outline of that sheath. The finger is held in a slightly flexed position and there is excruciating pain on extension. When the blind proximal end of the sheath ruptures into the thenar or mid-palmar space there are the added signs of these space infections.

In infections of the synovial sheath of the flexor longus pollicis (radial bursa) there is swelling and redness over the thumb with tenderness over the anatomical outline of the bursa. On extension there is considerable pain and tenderness over the flexor surface of the wrist.

In infection of the ulnar bursa there is swelling and redness of the little finger with excruciating pain on extension. Hand is semi-flexed at the wrist; usually all fingers, and many times the thumb, are partially flexed. There is tenderness over the anatomical distribution of the bursa.

Treatment for infections of a tendon sheath or fascial space is incision and drainage, thin rubber-dam or a piece of rubber glove should be used for
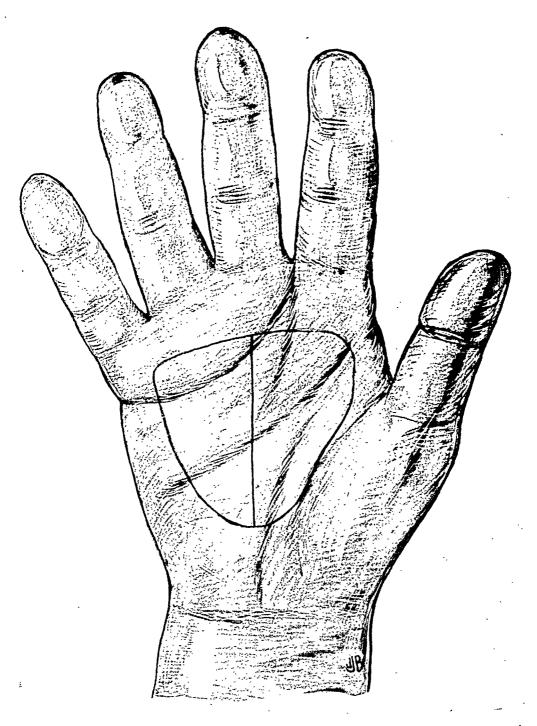
FIG. 1.—Diagram showing the positions of the mid-palmar and thenar spaces. The thenar space is to the radial side of the mid-line of the middle finger and extends distally to about a thumb's breadth of the web and proximally to about two thumbs' breadth of the wrist flexion crease. The mid-palmar space is to the ulnar side of the mid-line of the middle finger and extends distally and proximally as the thenar space (after Kanavel).

drainage material as it causes less trauma. Many times no drainage material is necessary. A large voluminous wet dressing is then applied extending from the hand to above the elbow. Hot boric acid solution is used and should be reapplied every two hours. During the interval the dressing is surrounded
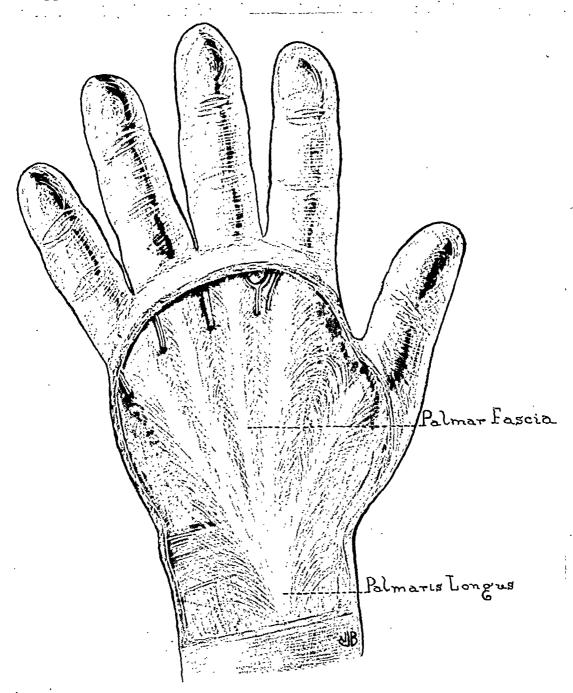
FIG. 2.—The skin and superficial fascia have been removed from the palm of the hand, exposing the palmar fascia which fans out to the base of the fingers. In the webs the fascia is thinner and the blood vessels and nerves may be seen through this layer.

by hot water bottles or a dry heating apparatus, such as a large electric light bulb. Since rest is most important in the early stages it is well to splint the arm in a large pillow. The wet dressings are continued for two to four days and then the hand soaked in hot boric solution, two to three times a day for

about one-half hour, followed by dry heat for one hour beneath the cradle or other heating apparatus. While the hand is in the hot soak and under the dry heat, both active and passive motions are encouraged. In infections of the hand the position of function as emphasized by Kanavel and Koch must always be kept in mind; that is dorsiflexion of the wrist, flexion of the
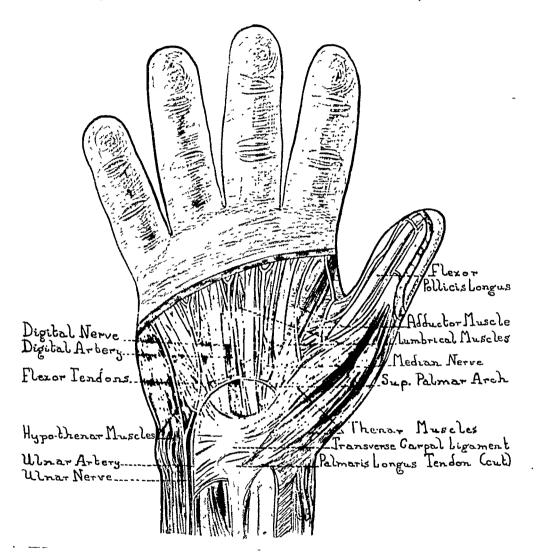


FIG. 3.—The palmar fascia has been removed, exposing the flexor tendons, the superficial palmar arch and branches of the ulnar and median nerves. The radial bursa is a synovial sheath around the flexor pollicis, longus tendon. The ulnar bursa is a synovial sheath around the flexor tendon to the little finger. The mid-palmar and thenar spaces lie deep to the structures shown in this plate. There are four lumbrical muscles, each having origin on a flexor tendon and passing around the radial side of the finger insert on the extensor tendon over the proximal phalanx.

fingers, as in grasping a ball, and abduction of the thumb so as to have the palmar surface of the thumb face the palmar surface of the index finger. Baking and massage, active and passive motion are then continued through convalescence. Too much emphasis cannot be placed upon the treatment during this period of recovery.

Return of function in fascial space infection is usually very good, but synovial sheath infection can never be expected to reach 100 per cent.

Volar Interosseous M.

Dorsal Interosseous M.

Hypo-thenar M.

Deep Palmar A-k.

Flexor Tendons Cut.

Transverse Carpal L.

Ulnar Arte

Ulnar Nerve.

Lumbrical Muscle

Adductor Transversus M.

Adductor Obliquus M.

Thenar Muscles

Radial Artery
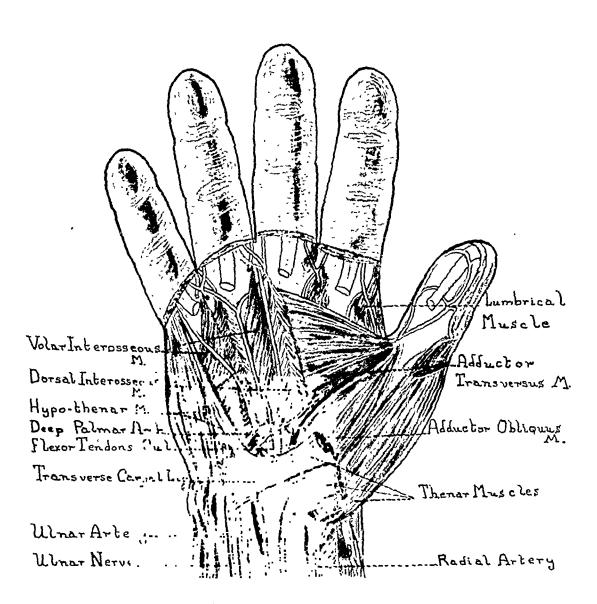
FIG. 4.—The flexor tendons, with the superficial arch and branches of the median and ulnar nerves, have been removed, exposing the floor of the mid-palmar and thenar spaces. The deep palmar arch is exposed. The floor of the mid-palmar space consists of the interossei muscles. The floor of the thenar space consists of the adductor muscles.
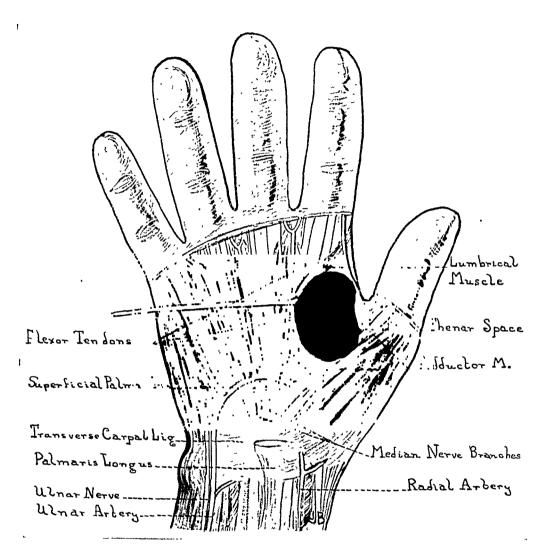
FIG. 5.—Gelatin injected into the radial side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the thenar space between the thumb and index finger, and over the adductor muscles. The lumbrical muscle and flexor tendon of the index finger have been pulled toward the mid-line. Pus may travel around the border of the adductor muscle in the web and appear on the dorsum between the thumb and index finger.
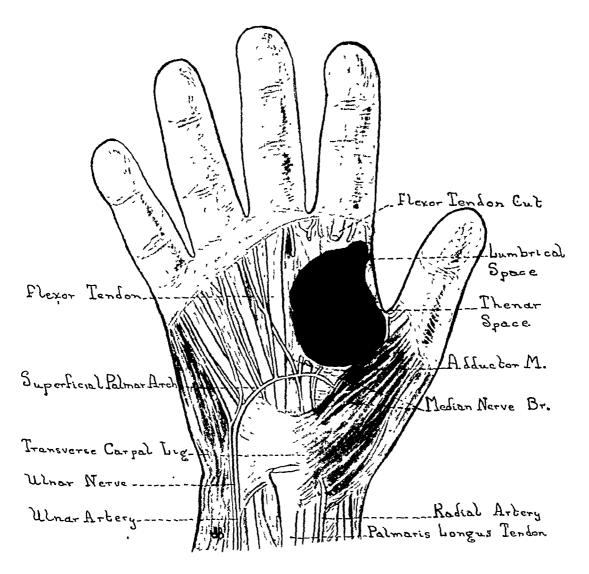
Fig. 6.—Gelatin injected into the radial side of the mid-line of the middle finger by thrusting the needle into the palm, showing how pus only extends to the mid-line of the middle finger. Under sufficient pressure it may break through the connective tissue barrier and into the mid-palmar space. However, this seldom occurs because it is usually rather early diagnosed by the swelling over the thenar area and on the dorsum between the index finger and thumb. The flexor tendon of the index finger has been removed.
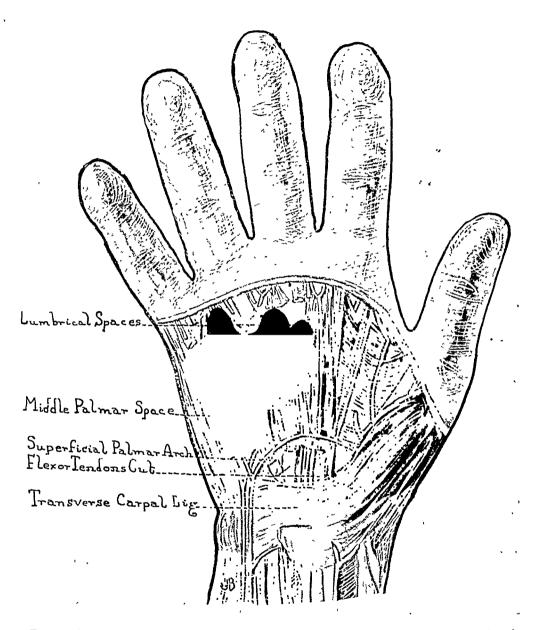
FIG. 7.—Gelatin injected into the ulnar side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the mid-palmar space. The flexor tendons and lumbrical muscles of the middle, ring and little fingers have been removed. Pus is extending distally along the lumbrical muscles (lumbrical spaces) toward the radial side of the fingers.

Lumbrical Space

Flexor Tendon
Mid Palmar Space

Ulnar Artery
Ulnar Nerve

Thenar Space
Median Nerve Br.

Sup. Palmar Arch

Transverse Carpal Lig.
Palmaris Longus Tendon
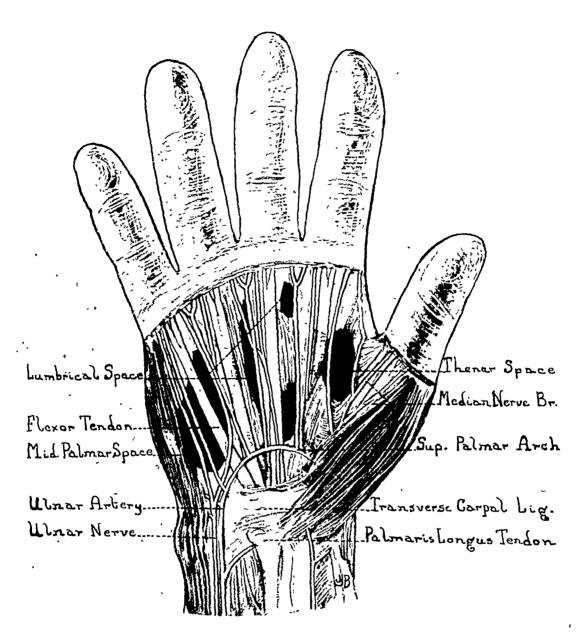
FIG. 8.—Gelatin injected into the ulnar side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the mid-palmar space and under increasing pressure may break through the connective tissue barrier to the thenar space. The flexor tendons are still intact.
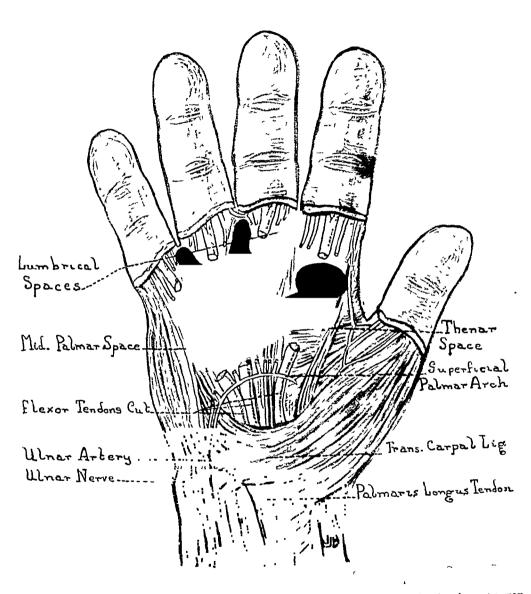
FIG. 9 —This is the preceding experiment with the flexor tendons removed, showing how pus may break into the thenar space and extend distally along the lumbrical muscles (lumbrical spaces) and through the web and onto the dorsum of the proximal phalanx.

Disten ded Lumbrical
Spaces
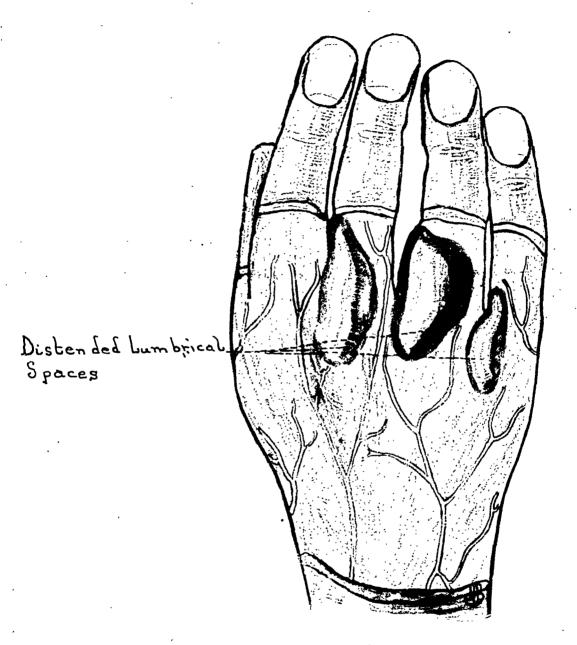
FIG. 10.—This is the dorsum of the hand in the preceding experiment, showing how pus has traveled along the lumbrical muscles (lumbrical spaces) on the radial side of the middle, ring and little fingers to reach the dorsum of these fingers over the proximal phalanx.
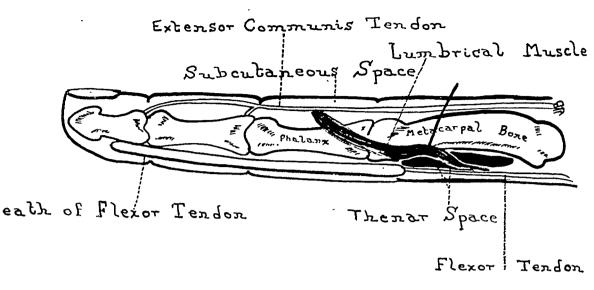
FIG. 11.—Diagram showing the relation of the lumbrical muscles to the dorsum of the proximal phalanx and a thenar or mid-palmar space. The lumbrical muscle (hooked up) arises from the flexor tendon over the mid-palmar or thenar space and extends distally around the radial side of the base of the finger to insert on the extensor tendon over the dorsum of the proximal phalanx. This shows how pus may extend from the palm and appear on the dorsum of the proximal phalanx and web as shown in Fig. 10. Infection may also travel from the dorsal subcutaneus space along the lumbrical muscle to the palm. Diagram also shows how the flexor tendon sheaths of the index, middle and ring fingers end blindly at the thenar or mid-palmar space and in close relation with the lumbrical muscle (space).
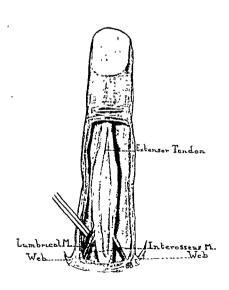


FIG. 12.—The lumbrical muscles of the index, middle, ring and little fingers pass around the radial side of the base of these fingers and insert over the dorsum of the proximal phalanx into the extensor tendon and its fibrous expansions. Volar and dorsal interossei muscles pass around both sides of the base of the fingers and insert on the extensor tendon and its fibrous expansions. Around the interossei muscles and particularly the lumbrical muscles on the radial side of the base of the proximal phalanx are areas of rather loose connective tissue where infection and pus in the region of the proximal phalanx may extend into the web. This explains why infections in this region are prone to heal slowly because of insufficient drainage of these lumbrical and interossei spaces.

Ulnar Bursa

Flexor Tendon Sheaths

Radial Bursa
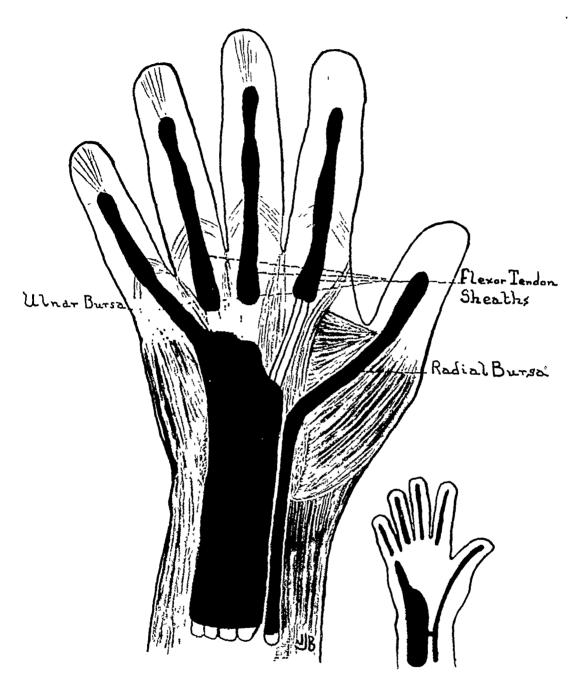
FIG. 13.—Diagram similar to those in textbooks showing the tendon sheaths. Every tendon has a fibrous sheath but only those tendons have a synovial sheath where there is an intricate mechanism or considerable motion and friction. The flexor tendon sheath (radial bursa) of the thumb extends about two thumbs' breadth above the flexion crease of the wrist. The flexor tendon sheath (ulnar bursa) of the little finger extends about two thumbs' breadth above the flexion crease of the wrist. It envelops the tendons of the other fingers beneath the transverse carpal ligament forming a large intercommunicating bursa or divides into several independent noncommunicating bursæ. The tendon sheaths of the index, middle and ring fingers extend about a thumb's breadth above the base of the finger. The small diagram shows the communication between the ulnar and radial bursæ which is present in about 60 per cent. of cases, and explains the frequent traveling of infection between these two bursæ. In about 25 per cent. of cases there is a break in the continuity of the ulnar bursa over the base of the little finger as shown in the smaller drawing.
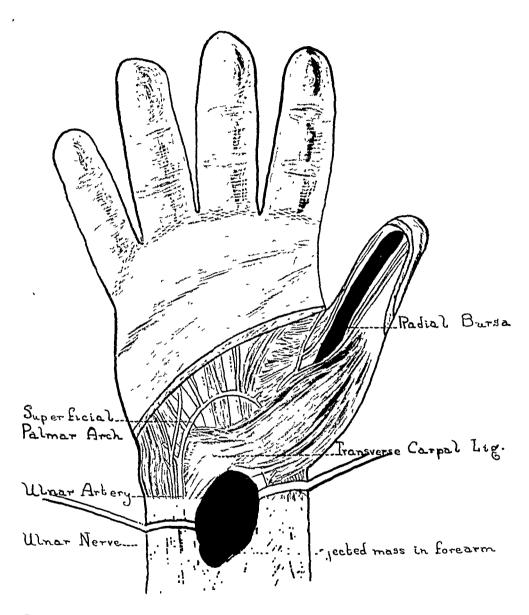
Fig. 14.—Gelatin injected into the synovial sheath (radial bursa) of the flexor pollicis longus tendon and shows how pus may extend proximally along the bursa and under sufficient pressure may rupture into the forearm deep to the flexor muscles and over the pronator quadratus muscle. The flexor tendons have been separated, exposing the mass in the forearm.

Flexor Tendon Sheath

Thenar Space

Adductor M.

Flexor Tendon Cut

Transverse Carpal Lig.
Ulnar Nerve
Ulnar Artery
Palmaris Longus
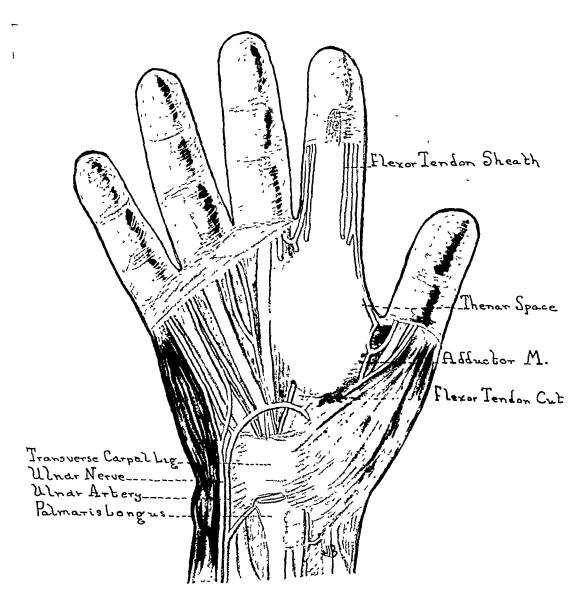
FIG. 15.—Gelatin injected into the flexor tendon sheath of the index finger, showing how pus under sufficient pressure may rupture through the blind proximal end of the sheath into the thenar space. The flexor tendon of the index finger has been removed.

Flexor Tendon Sheath

Lumbrical Space

Mid-Palmar Space

Lumbrical M.
Adductor M.

Flexor Tendons Cut
Superficial Palmar Arch

Transverse Carpal Ligament
Palmaris Longus Tendon
Ulnar Nerve
Ulnar Artery
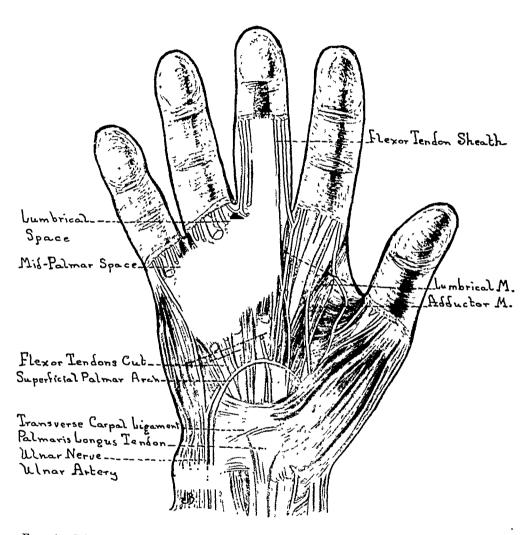
FIG. 16.—Gelatin injected into the flexor tendon sheath of the middle finger, showing how pus under sufficient pressure may break through the blind proximal end of the sheath into the mid-palmar space. Only occasionally has this sheath ruptured into the thenar space. The flexor tendons of the middle, ring and little fingers have been removed
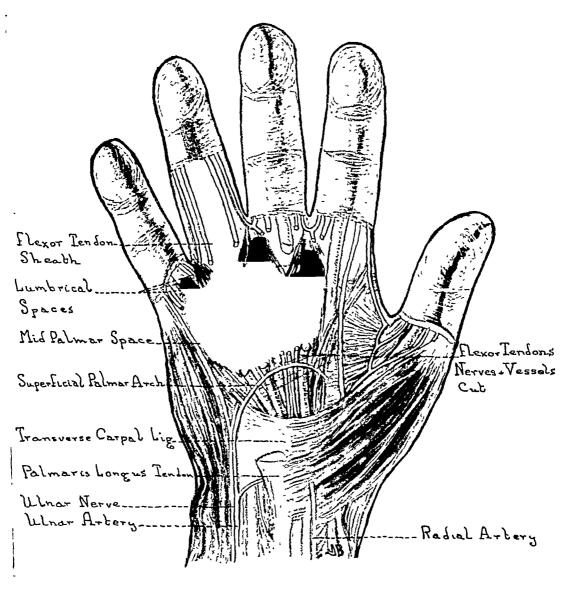
FIG. 17.—Gelatin injected into the flexor tendon sheath of the ring finger, showing how pus under pressure may break through the blind proximal end into the mid-palmar space. The flexor tendons of the middle, ring and little fingers have been removed.

Ulnar Bursa

Superficial Palmar Art.

Median Nerve Br.

Transverse Carpal Lig.

Ulnar Nerve
Ulnar Artery
Ulnar Bursa

Deep Fore-arm Space
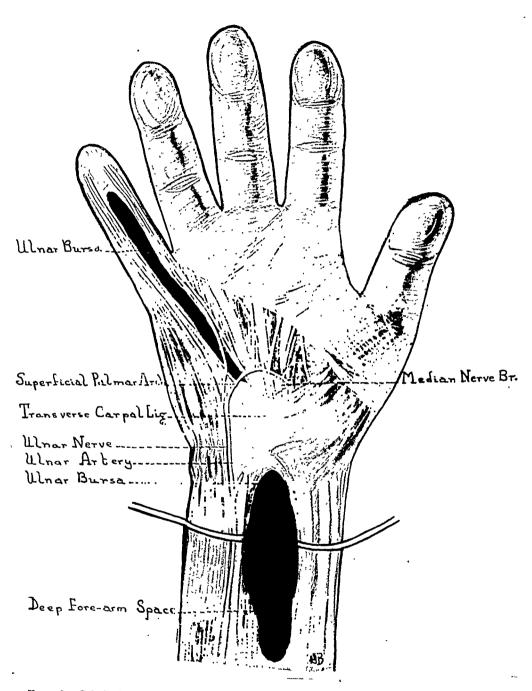
FIG. 18.—Gelatin injected into the ulnar bursa, showing how pus travels proximally in the bursa and under sufficient pressure breaks into a space just above the wrist and deep to the flexor tendons and over the pronator quadratus muscle. The flexor tendons have been separated to expose the mass deep in the forearm.

FIG. 19.—Diagram showing incisions for drainage of the ulnar and radial bursae and synovial sheaths of the fingers. Incision for the radial bursa begins over the proximal phalanx, extends upward and medialward keeping just to the medial side of the thenar eminence since the bursa is overlapped by the thenar muscles. Incision should only extend to within about two thumbs' breadth of the wrist flexion crease because of a motor nerve to the thenar muscles crossing the bursa at this level. The incisions for drainage of the synovial sheaths of the fingers should be on the lateral surface and interrupted over the interphalangeal joint so as to prevent prolapse of the tendon and a resulting bowstring deformity. If the ulnar bursa is incised as above and the bursa further drained by an incision beginning near the web and keeping to the medial side of the hypo-thenar eminence and extending proximally to about a thumb's breadth below the flexion crease of the wrist so as to avoid injury to the superficial palmar arch. However, at times it is necessary to extend this incision somewhat higher. The communication between the ulnar and radial bursa is present in about 60 per cent. of the cases, and incisions of both bursae may be necessary. The incisions on the forearm are for drainage of the upper ends of these bursae and the deep forearm space from rupture of the proximal blind ends of the radial or ulnar bursae. These incisions are made over the ventrolateral aspect of the radius and ulna and then blunt forceps forced over their volar surfaces and beneath the flexor tendons so as to establish through and through drainage. Care is necessary with incision on the radial side to avoid injury to the radial artery.

Fig. 20.—Diagram showing lines of incision for drainage of the thenar and mid-palmar spaces. The thenar space is drained by an incision in the web between the thumb and index finger, as seen on both the large and the upper small drawing. After incising skin and fascia the adductor muscle is exposed as a band between the base of the thumb and index finger. By going to the palmar side of this muscle band with a blunt forceps the thenar space is opened. It is well to open the space to the dorsum, as pus in the thenar space usually travels around the free edge of the adductor muscle to the dorsum. The mid-palmar space may be opened by an incision beginning at the web and extending proximally about one inch between either the middle and ring fingers or ring and little fingers, or both. The lumbrical space may be further opened by extending the incision along the radial side of the proximal phalanx as shown in the lower small drawing. The incision for drainage of the lumbrical and interossei spaces is shown in the lower small drawing.

# STRICTURE OF THE MALE URETHRA

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A high morbidity and a relatively high mortality renders stricture of the urethra of prime importance among surgical lesions of the urinary tract. Stricture may occur in either sex and, depending upon its etiology, at any age. In a recent study of 1538 cases of surgical lesions of the male urethra admitted to the Urological Service of Bellevue Hospital, from April 1, 1910, to January 1, 1928, we discovered that stricture was the principal or underlying surgical disease in over three-fourths of these patients. Because of the relatively long period of time covered by this study, these patients were treated by many different operators and, with urological advances, some changes in the routine pre-operative, operative and post-operative measures have been made. Of great importance was the introduction of the phenolsulphonephthalein renal function test and the routine use of chemical analysis of the blood. Of great satisfaction has been the development in recent years of spinal anæsthesia in preference to general anæsthesia for urethral surgery. All phases of stricture as observed in 1244 males are here presented. Particular interest focuses on treatment and its results.

Etiologically stricture may be classified: 1. Spasmodic. 2. Congenital. 3. Acquired:—Traumatic. Inflammatory.

Spasmodic stricture is neurogenic in origin, caused by contraction of the compressor urethræ muscle, occurs in the membranous urethra, and is cured by over-dilatation. De Bovis[1] has reported two cases of spasmodic stricture of the anterior urethra but we have not recognized an instance of this condition. Strictly speaking, however, spasmodic stricture is but the symptomatic expression of an irritation reflex. There may be an associated organic stricture.

Congenital stricture is usually asymptomatic and located chiefly at or just within the meatus. Of the two locations, the latter $\frac{1}{2}$ to 1 cm. within the urethral orifice is the most common, and congenital strictures here are often extremely dense. The presence of these lesions is made known by the acquisition of a urethritis which will not be cured until the stricture has been cut or dilated to normal calibre. In our series but one stricture was determined to be definitely congenital. This was cut.

According to the statistics of others, traumatic stricture constitutes 5 to 10 per cent. of urethral obstructions excepting those of the prostate. We found but twenty-three (1.9 per cent.) such cases among the 1244. While clinically traumatic stricture is more rapid in development and therapeutically more obstinately tenacious than inflammatory stricture, the treatment is the same as

applied to the latter though prolonged, and, as a rule, traumatic strictures require cutting. The membranous urethra is most frequently involved for here are received the crushing blows of the so-called "straddle injuries" of the perineum.

Over 90 per cent. of urethral strictures are of inflammatory origin; the gonococcus is predominately the invading organism. It is primarily with this type of stricture that we are here concerned. Gonococcus infection was denied in sixty cases but one tends to consider this as faulty diagnosis or bare falsification since in some of these gonococci were subsequently revealed.

*Etiology.*—By definition, a urethral stricture is a pathological diminution of the lumen or of the distensibility of this canal. Normally the calibre of the channel is not like a straight tube as conceived by Otis, but varies greatly with definite anatomical constrictions and dilatations. (Fig. 1.) While there is no universally accepted form a 30 F. sound may be passed through most non-inflamed adult urethræ without difficulty. For some surgeons, a constriction having a calibre of 23 F. or less constitutes a stricture (Oberlander[2]); for others, but what is essentially the same, a scar of sufficient degree to grasp a 26 F. sound (Keyes[3]). It is usu-



FIG. 1.—Normal variations in calibre of male urethra. Dilatations of anterior (fossa navicularis), deep bulbous and prostatic urethra are noteworthy. The subdivisions of the urethra as designated clinically are indicated. In our series the location of the stricture of maximum intensity as revealed by examination or operation follows: Pendulous urethra 242, bulbous 206, bulbo-membranous 247, membranous 99, prostatic none.

ally observed that a stricture which will offer the characteristic obstruction or "hang" to an olivary bougie of calibre 23 F., for example, will require the passage of a much larger sound before grasping is elicited.

The histology of the urethral lumen goes far in explaining certain phases of stricture, particularly its sites of predilection. Columnar and cylindrical epithelium is an unusually good breeding ground for gonococci. It lines the urethra from the external meatus to the membranous portion where transition to infection-resistant squamous epithelium (continuous to prostatic urethra and bladder) occurs. Because of this resistance to infection and the absence of glandular structures in the membranous urethra, stricture in this location is less frequent. On the other hand, the innumerable glands and crypts interspersed among the columnar cells offer favorable habitat for inflammatory foci, notably in the bulbous urethra.

The inflammatory process alone rarely causes stricture; the latter seldom

follows a well-treated gonorrhœa. Too forceful injections, the injection of hyper-irritating solutions, the unskilful passage of instruments or the break-ing of a chordee are common trauma which serve but to intensify and prolong the inflammatory process. To quote Keyes, "the man behind the gun is more important than the solution in it."

Broadly speaking, stricture is a disease of the fourth, fifth, and sixth decade. Though the gonorrhœa be acquired early in life, the stricture does not usually manifest itself symptomatically until months or years later. Prac-tically three-fourths of our patients were between thirty and sixty years of age, the youngest was sixteen, the oldest ninety-one. (Table I.) Over one-half had but one attack of gonorrhœa (Table II), and in this group we may gather rather accurate data indicating the relative latency between the acute infection and the appearance of stricture symptoms. It will be noted that of the 714 having had but one attack, 119 developed symptoms of stricture within one year or less. The shortest interval was one month. Five developed symptoms of strictures within two months. (Table III.)

TABLE I.

| | |
|---|---:|
| 19 and under | 6 |
| 20–29 | 203 |
| 30–39 | 275 |
| 40–49 | 296 |
| 50–59 | 251 |
| 60–69 | 134 |
| Over 70 | 43 |
| Not recorded | 36 |
| | 1244 |

TABLE II.

*Incidence of Gonorrhœal Infection.*

| | |
|---|---:|
| Denied | 60 |
| Number of infections | |
| 1 | 714 |
| 2 | 142 |
| 3 | 42 |
| 4 | 23 |
| 5 | 14 |
| Several | 42 |
| Had | 9 |
| Present now | 39 |
| Not recorded | 157 |
| | 1242 |

TABLE III.

*Time Relationship Between Gonorrhœa and Initial Stricture Symptoms.*

| | Years | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Under 1 | 1 | 2 | 3 | 4 | 5–9 | 10–15 | Over 15 |
| One attack only | 27 | 92 | 43 | 32 | 35 | 29 | 133 | 299 |
| First G. C. | 1 | 1 | 4 | 7 | 81 | 41 | 52 | 101 |
| Last G. C. | | 43 | 27 | 15 | 20 | 44 | 31 | 31 |

A great number of our patients suffered several attacks of gonorrhœa, and it is quite impossible to determine with accuracy when the stricture began although a history of repeated attacks presses one to the conclusion that stricture followed the initial inflammation and many, if not all, of the succeeding infections were flareups. (Table III.) Two patients alleged to have had twelve gonorrhœa infections each.

Of great interest, particularly in shedding light on the prognosis after operation, was a group of 348 stricture cases who had been operated upon previously—317 once, and thirty-one, two or more times. One patient had had nine urethrotomies performed. Three had had previous operations for urinary extravasation, twenty-nine had been operated on for periurethral abscess, and one for prostatic abscess. A large number, not indicated in the tabulations, had had sounds passed intermittently over variable periods of time but had ceased this precaution when contracture of the scar made instrumentation difficult or painful. (Table IV.)

TABLE IV.

*Previous Operations for Urethral Stricture.*

Times
operated

| | |
|---|---|
| 1 | 317 |
| 2 | 20 |
| 3 | 7 |
| 4 | 2 |
| 7 | 1 |
| 9 | 1 |

Interval since
operation

| | |
|---|---|
| Less than 2 years | 60 |
| 2 to 4 years | 72 |
| 5 to 6 years | 33 |
| 7 to 10 years | 65 |
| Over 10 years | 101 |
| Not stated | 17 |

| | |
|---|---|
| With associated periurethral abscess | 29 |
| For prostatic abscess | 1 |
| For extravasation of urine | 3 |

*Pathology.*—The pathology of urethral stricture is that of chronic urethritis plus scar formation. This was carefully worked out by Oberlander. He found that with the transformation of the acute to chronic urethritis the following changes occur:

1. Organization of the periglandular inflammatory exudate into scar proportional to the severity of the inflammation.

2. If the glandular exudate can drain into the canal, intraglandular or intracryptic inflammation continues as a chronic catarrh (glandular urethritis of Oberlander); if the gland orifices are plugged by firm exudate, a glandular abscess or colloidal cyst is formed (dry urethritis of Oberlander). Further, the gland may be obliterated by scar or may return to normal.

3. The mucosa remains chronically inflamed. Oberlander designated

as soft infiltration that lesion which urethroscopically appears as a reddened mucosa dotted by still more red suppurating duct orifices and with slight sclerosis of the walls indicated by diminution of the normal folds and urethral striæ.

The next stage or hard infiltration of Oberlander is characterized urethroscopically by loss of striæ or folds, a rigid urethral wall against the striking pallor of which the reddened orifices of inflamed glands stand out in sharp contrast. There may be erosions, ulcerations, granulations or papillomata. Increased scar formation with resulting anæmia explains the mucosal pallor. Infection accounts for ulceration and erosion while various stages of the repair process produce granulations and, if exaggerated, papillomata.

Intensification of this latter process, the hard infiltration of Oberlander, results in the condition we observe clinically as stricture.

In the transition from chronic urethritis to clinical stricture the Finger-Gujon theory assumes the urethritis to be always a sclerotic process, the degree of stricture being proportional to the duration of the inflammation. Since sclerotic repair is proportional to the severity of the inflammation and we do see stricture developing in a period of weeks in the presence of unusually acute urethral infections whereas chronic urethritis may persist for years without stricture formation, Guiard's theory—that stricture is dependent upon the severity of the localized infection—may be universally applied.

Clinically and pathologically, traumatic strictures are usually single. On the other hand, gonorrhœal strictures are often multiple. For while pathologically a lesion may appear as a broad band of scar, let a bougie à boule be passed through this sclerosed canal and a series of ridges will be noted. Urethroscopy may likewise reveal a series of constrictions. When multiple, it will be observed that the innermost stricture is usually the tightest and because of repeated assault and pressure of the urinary stream against this barrier, the urethra is dilated behind it. At the site of stricture, inflammation is increased and not infrequently intense glandular and periglandular abscesses develop. These may remain localized or may invade the corpus spongiosum and spread beneath or rupture through the skin, or rupture into the urethra— the clinical picture of periurethral abscess. This latter process may ensue at any point along the urethra with or without the presence of stricture, but when stricture is present, the constricted area is the site of predilection for abscess formation. On longitudinal section, the strictured urethra may present anything from an isolated constriction to a series of circular scars extending from the meatus to the prostatic urethra. There may be granulations, polypoid overgrowths of squamous epithelium which has replaced ulcerated columnar, or various knotty areas of scarring often with associated abscesses may infiltrate the corpus spongiosum and be externally palpable. Such swellings we noted on physical examination thirty times in the anterior urethra, fifteen times in the anterior bulbous, and seventy-five times in the perineal urethra.

With prolonged obstruction, urinary back pressure causes dilatation of the

proximal organs and eventually urinary sepsis intervenes. The deep urethra becomes pouched, the bladder wall hypertrophied, sclerosed, later atrophic and often the site of acute inflammatory ulceration. The upper urinary tract damage is most vital. The ureters may become dilated six to ten times their normal calibre, atonic and sclerotic. Renal injury is proportional to the

TABLE V.

*Frequency of Urination.*

| | | | | | Times | | |
|---|---|---|---|---|---|---|---|
| | 1–2 | 3–4 | 5–6 | 7–10 | Over 10 | "Many" | Involuntary |
| Day................. | | | 142 | 62 | 118 | 124 | 70 |
| Night................. | 129 | 137 | 109 | 24 | 59 | 120 | 71 |

degree and duration of the obstruction, and may jeopardize life. It is, therefore, in terms of renal function that we consider stricture, both therapeutically and as to prognosis. In some cases of long standing we have found the renal function to be practically nil and autopsy has revealed hydropyonephrosis with no grossly discernible renal cortex.

Stricture of the prostatic urethra follows gonorrhœa only in association with other strictures anteriorly. As an isolated lesion it most often follows fracture of the pelvis with laceration of the prostatic canal. Strictures of the membranous urethra are almost always traumatic in origin. The most common site of inflammatory stricture is the bulb and bulbo-membranous urethra. In this study the urethra has been divided into the five arbitrary divisions we have been accustomed to employ clinically at Bellevue: penile or pendulous, bulbous or scrotal, bulbo-membranous, membranous or deep, and prostatic.

To be strictly anatomical these divisions are incorrect. Anatomists divide the urethra at the junction of the bulbous and the membranous portions into (1) anterior, (a) pendulous or penile extending from the external meatus to the suspensary ligament, (b) bulbous or scrotal from the suspensary ligament to the posterior boundary and (2) posterior, consisting of the membranous and the prostatic segments, the apex of the prostate subdividing these. Unless one is fortunate in performing a satisfactory perineal dissection and is able to recognize distinctly the anatomical landmarks at operation (quite hopelessly impossible in the presence of marked perineal periurethral infection or phlegmon), it is far more convenient clinically to designate as the bulbo-membranous urethra that short segment comprising the terminal bulbous and the beginning membranous urethra which is so often the site of intense sclerosis. This has been our practice at Bellevue; we are aware that this designation is used by others. The location of the stricture causing the greatest obstruction as revealed by instrumentation, endoscopy or operation is indicated in Figure 1. Often the strictures were multiple; in such instances the deepest has always been considered the most flagrant.

*Symptoms.*—The recognition of many surgical diseases and their surgical treatment is recorded in the medical literature of antiquity. Not so with stricture. Probably the earliest essay on this subject is that of John Read published in 1588.[4]

As a rule the symptomatic onset of stricture is insidious. Although unnoticed by the patient, the continuous urinary obstruction slowly brings about a variable degree of urinary tract stasis and dilatation with accompanying infection. Later appear the definite clinical signs and symptoms so characteristic of urosepsis. While this is going on more active symptoms become manifest.

It is interesting to note how many years some patients have neglected themselves after the appearance of urethral symptoms. For years, many have been fully aware of the nature of their lesions. The duration of symptoms as elicited by history are shown in Table VI.

TABLE VI.

*Duration of Symptoms of Stricture.*

|  | Acute retention | "Stricture" | Urinary difficulty | Diminished stream | Dribbling |
|---|---|---|---|---|---|
| **Days** | | | | | |
| 1 | 6 | | 8 | 2 | 8 |
| 2 | 2 | | 2 | 2 | 7 |
| 3 | 20 | | 8 | 8 | 7 |
| 4 | 2 | | 11 | 8 | 7 |
| 5 | 10 | | 7 | 3 | |
| 6 | 3 | | 1 | | 1 |
| **Weeks** | | | | | |
| 1 | 28 | | 25 | 14 | 5 |
| 2 | 9 | | 18 | 12 | 6 |
| 3 | | | 13 | 7 | 7 |
| **Months** | | | | | |
| 1 | | | 13 | 11 | 6 |
| 2 | | 149 | 14 | 18 | 9 |
| 3 | | | 11 | 12 | 9 |
| 4 | | 61 | 13 | 11 | 1 |
| 5 | | | 1 | | 2 |
| 6 | | | 17 | 15 | 8 |
| 7–12 | | 87 | 9 | | |
| **Years** | | | | | |
| 1 | | | 34 | 37 | 10 |
| 2 | | 124 | 34 | 25 | 13 |
| 3 | | 69 | 21 | 27 | 6 |
| 4–5 | | 99 | 13 | 10 | 5 |
| 6–10 | | 136 | 75 | 50 | 11 |
| 11–15 | | 61 | 37 | 18 | 2 |
| Over 15 | | 101 | 23 | 12 | 5 |
| "Years" | | 171 | | 9 | |
| Present | | | 325 | 276 | 136 |
| Chronic retention | 29 | | | | |

Diminution of the urinary stream and its corollaries—urinary difficulty and dribbling are, as a rule, the first symptoms noted. The tightening stricture and faulty accelerator urethral muscle action resulting from periurethral sclerosis in the corpus spongiosum causes the last few drops to be withheld in the canal. This urine subsequently gravitates into the clothing. Changes

in the urinary stream other than diminution and irregularity are not suggestive of stricture. The legendary forked stream so generally associated in the minds of many with stricture is dependent entirely upon the conformation of the meatal nozzle. Adherent mucus may bring this about.

The persistent urethral discharge or gleet which accompanies most strictures is the symptom to first arrest the attention of many and cause them to seek treatment. While unquestionably present even more often, it was noted in this series 194 times. Too, when discharge is not grossly evident, the voided urine will always contain shreds in the presence of stricture. A shred is discharge.

Frequency, unless marked, causes little concern. A few complained because nocturia disturbed sleep. We noted furthermore that practically all patients urinating more than five times a day, voided at least once during the night. (Table V.) Associated prostatitis with vesicle neck irritation, cystitis, and renal congestion with polyuria are chief of the known cases of this frequency. With all strictures there is associated prostatitis.

Hæmaturia heralded the presence of stricture in but three cases. By its rarity here, this is quite in contrast to the findings of many. In 121 cases gross hæmaturia was noted at some period of the disease. Urinalysis revealed blood in 231. Unquestionably due to instrumental trauma in many cases, bleeding from urethral ulceration, granulation, polyps or erosions accounts for hæmaturia in the remainder.

Pain or burning on urinating was noted 394 times and was most often described as scalding in character. Usually of prostatic origin, it may be most intense at the bladder neck but may be localized at the frenum, in the perineum, or along the urethral canal.

Nodules of sclerosis along the course of the urethra (exclusive of clinical periurethral abscess) were noted by 170. Doubtlessly many of these nodules were well on their way to becoming definite periurethral abscesses; others were merely extensive areas of periurethral sclerosis often containing small areas of anæmic necrosis.

Occasionally acute retention may be the initial symptom as in eighty of our cases. Pathologically an acute congestion at the site of stricture, it is most often precipitated by exposure to wet, cold or by excesses—gastric, alcoholic, or sexual. In twenty-nine the urinary obstruction amounted to chronic retention with overflow dribbling. The subsequent course in these cases is identical with that of chronic prostatic obstructions. If unrelieved, early death ensues.

In this series we have no data bearing on the relationship of stricture to sexual performance. It is well known, however, that in the presence of advanced stricture (and sometimes even moderate), sclerotic involvement of the periurethral corpora may render the patient impotent, chiefly by sufficient obliteration of the corporeal meshes. Other symptoms of sexual dysfunction are secondary to accompanying prostatitis, seminal vesiculitis and verumontanitis.

*Physical Examination.*—Not infrequently in the course of the examination for another condition of the urinary tract, urethral stricture will be disclosed as the underlying cause. On the other hand, in examining patients for stricture, we often disclose associated disease. (Table VII.) Epididymitis

TABLE VII.

*Physical Examination.*

|  | Absent | Abscess | Indurated | Enlarged | Tender | Boggy | Undescended |
|---|---|---|---|---|---|---|---|
| Scrotum...... |  | 115 |  |  |  |  |  |
| Testicle....... | 9 | 4 |  | 12 |  |  | 4 |
| Epidid........ | 1 |  | 98 | 10 | 14 |  |  |
| Prostate....... | 3 | 5 | 157 | 309 | 71 | 79 |  |
| Sem. ves....... |  |  | 107 |  | 9 |  |  |
| Perineum...... |  | 182 | 173 |  |  |  |  |

usually due to the pyogenic cocci or the colon bacillus frequently accompanies stricture. It may at times be the initial symptom and because of the characteristics of its particular bacterial etiology these lesions often terminate in suppuration. Fourteen of our patients had acute epididymitis, bilateral in two. Subacute epididymitis was noted twice, tuberculous epididymitis once, scrotal abscess eight times in cases without extravasation, hydrocele nine times (once ruptured).

Often an acute orchitis will accompany epididymitis or may appear as an apparently distinct lesion. Orchitis is most often caused by the same organisms causing the epididymitis and is, therefore, characteristically a suppurative process necessitating orchidectomy as in five of our cases. The testicle was noted to be enlarged and tender in twelve, atrophic in several, surgically absent in nine, and undescended in four.

Prostatitis and seminal vesiculitis are an integral part of the stricture picture. We found the prostate absent (surgically removed) in three, boggy in seventy-seven, adenomatous in six, indurated in 157, carcinomatous twice, tuberculous once, abscessed in five, and enlarged by inflammation in 309. Seminal vesiculitis, acute and chronic, was noted 116 times with abscess once, although inflammatory changes in both the prostate and vesicles are of far greater incidence than these figures would indicate. It should be added that this one vesicle abscess subsequently ruptured into the peritoneal cavity with fatal outcome.

Periurethral abscess is perhaps the most common surgical complication of stricture and was observed 188 times (15 per cent.). It represents the suppuration of nodular periurethral infiltration. The onset may be so rapid that the various phases of adenitis, periadenitis and infiltration are unrecognized by the patient. These abscesses were found most often along the perineal urethra but are not uncommon to the scrotal and penile urethra.

Extravasation of urine is but a step further in the picture of periurethral phlegmon. (Fig. 2.) Of 132 cases of urinary extravasation observed, in 112 stricture was determined to be the primary surgical lesion. Twenty of these

had been previously operated upon for stricture but had neglected subsequent instrumentation. The pathology of urinary extravasation we have described elsewhere.[5] Suffice it to say, urethral obstruction is not a pre-requisite and the urinary and phlegmonous diffusion is not always due to urethral rupture by force of obstructed urination. Most often the primary lesion is an adenitis, periadenitis and periurethral infiltration with suppuration. Infiltration by such urine as may escape into the tissues is through the ulcerated urethra at the point of the localized acute inflammatory process.

Many other conditions may be associated with stricture. Fistulæ are common. We found 102 in the perineum, fourteen in the anterior urethra, and eight were urethro-rectal. The orifices of fistulæ may be some distance from the urethra. They have been seen in the flank. The "watering pot" perineum is frequently observed.

One case presented a bullet in the urethra. Although the patient alleged he had been shot there many years before, the foreign body had unquestionably been otherwise and more recently introduced. Urethral calculi were found in eleven cases. Some of these were individual round stones, too large to pass the obstruction; in others several stones faceted together gave the picture so frequently presented by biliary calculi. One benign and one malignant papilloma (so diagnosed histologically) were discovered.



FIG. 2.—Urinary extravasation secondary to urethral stricture. Penile and scrotal swelling and gangrene with marked suprapubic infiltration are noteworthy.

Back pressure with its attendant dilatation and infection produces a true cystitis in most cases of stricture. Usually it is considered part of the clinical picture but rarely may become intensified to the stage of ulceration as noted twice. Diverticulæ were found twice; bladder calculi were removed five times. In three cases vigorous pre-operative urethral bleeding into the bladder so filled this viscus with clots that cystotomy was necessary.

Kidney damage is present in every case proportional to the duration and degree of the obstruction. Surgical kidney infections were encountered in thirteen patients, and renal calculus in one. The phenolsulphonephthalein tests recorded herewith (Table VIII) are not in each instance a true index of the actual renal damage as it would be observed histologically.

TABLE VIII.

*Functional Examinations.*

Urine:
  Plus 789
  Blood 231

Phenolsulphonephthalein test
(per cent. in 2 hours intramuscularly):

| | |
|---|---|
| None | 3 |
| Trace | 4 |
| Under 5% | 15 |
| 6–15% | 88 |
| 16–30% | 88 |
| 31–50% | 131 |
| Over 50% | 101 |

Blood pressure (systolic):

| | |
|---|---|
| Under 100 mm. Hg | 22 |
| 100–140 mm | 118 |
| 141–180 mm | 25 |
| Over 180 mm | 2 |

Non-protein nitrogen:

| | |
|---|---|
| Under 35 mgms. 100 c.c. | 317 |
| 36 to 50 mgms | 122 |
| 51 to 75 mgms | 36 |
| 75 to 150 mgms | 11 |
| Over 150 mgms | 7 |

Creatinin:

| | |
|---|---|
| Under 1 mgm. 100 c.c. | 6 |
| 1–2 mgms | 201 |
| 2–3 mgms | 69 |
| 3–4 mgms | 12 |
| Over 4 mgms | 9 |

Whether because of advancing years or of severe nephropathy with nitrogenous retention, cardio-vascular disease is a frequent clinical complication. A failing heart (myocarditis) prevents many post-operative recoveries.

On admission three patients were suffering from delirium tremens, four others were irrational and twenty-six were in terminal urosepsis. Twenty-one presented pulmonary complications in addition to stricture—tuberculosis, pneumonia, bronchitis, pleurisy, and pulmonary œdema. Seven were admitted with arthritis, of gonorrhœal origin in three, suppurative in three others, and tuberculous once. These various complications have been enumerated at length because when these associated lesions are severe, they may be the direct cause of an early death.

Laboratory findings and functional tests are, in a sense, a phase of the physical examination. (Table VIII.) Albuminuria usually means a toxic nephritis and often disappears with the establishment of proper urinary drainage. Blood cells may afford a false index to the quantitative estimation of renal albuminuria. Careful examination will always reveal a few pus cells. These may be present as (1) a microscopic finding or (2) in sufficient quantity to cloud the urine or (3) may constitute a goodly portion of the urine specimen. We have seen urine from these cases, the purulent sediment of which was over a third by volume.

Blood was noted as present, grossly or microscopically, in one of every six patients but we believe the actual incidence to be much higher.

Although long standing urinary retention is commonly supposed to cause increased blood pressure, in but two of 147 cases with recorded blood pressure was the systolic pressure over 180 mm. mercury. Once it was 235 mm.

and once 202 mm. In two-thirds of the recorded readings it ranged between 100 and 140 mm. and in twenty-one cases was less than 100 mm.

Blood chemistry and the phenolsulphonephthalein excretion estimation have constituted our renal function tests. The former tells what the kidneys have been doing in the immediate past; the latter what they are doing at the time of examination. The non-protein-nitrogen and creatinin findings were normal in two-thirds of the cases in which it was used. (Table VIII.) In seven, however, the non-protein-nitrogen was over 150 mgms. per 100 c.c. of blood, the highest being 300 mgms. In six cases the creatinin was over five mgms. per 100 c.c.; 7.2 mgms. was the highest. Two of these with five mgms. of creatinin per 100 c.c. survived. A creatinin estimation of three mgms. or over warrants an unfavorable prognosis although, as just seen, some of these patients will recover.

In later years the phenolsulphonephthalein test has been employed routinely. It is injected intramuscularly and the output for two hours estimated. In one-fourth of these it was found normal. Three showed none in two hours, four others but a faint trace. The total output was less than 50 per cent. in three-fourths of our recorded estimations. (Table VIII.)

Urethral smear revealed the gonococcus fifty-five times, the staphylococcus eighteen times, streptococcus twenty-two times and B. coli five times. Although a history of chancre was given by 248 patients, the Wassermann test was positive in but ninety-two. . This observation is of minor importance, however, as we observed no cases in which there was the question of intra-urethral chancre as the cause of stricture.

*Diagnosis.*—The passage of an instrument through, and the grasping of it by the scar constitutes the diagnosis of stricture. The bulbous or olivary bougie is the instrument of our choice. One first passes a large bulb, a 28 F., for example. If this can be passed one notes any obstructions to its introduction or to its free withdrawal. In the presence of stricture, as the instrument is withdrawn through the urethral scars, a jump or series of jumps will be felt. These are strictures of large calibre and one does well to observe them endoscopically also. If the 28 F. bulb will not pass, progressively smaller instruments are used until one is found which will pass the obstruction and will elicit the characteristic "hang" of stricture. Not infrequently no instrument can be passed, not even a whalebone filiform. On the other hand, many apparently small calibre strictures deceive in that difficulty of penetration of their lumina is due to tortuosity rather than tightness. In such cases a larger instrument will not infrequently go where the smaller is caught in irregular folds and abrasions. Lacerations of the urethra from recent instrumental trauma may also afford an apparently impassable channel. Certain strictures are found to be impassable.

Protracted sessions of instrumentation are ill advised in cases of acute retention, and once urethral obstruction (other than prostatic) is determined by a large instrument, filiforms may be profitably and wisely employed at once.

We have found the Phillips whip with a small follower catheter of great value since it combines filiform, dilatation and drainage.

Other diagnostic aids are the urethroscope and the steel sound. The urethroscopic picture of stricture, an intensely inflamed mucosa or, in the absence of acute congestion or recent instrumentation, a pallid membrane with numerous erosions, granulations, follicular infections against the rigid and rather straight sclerosed urethral wall, will indicate the lesion but gives no accurate data regarding its calibre unless the scar will permit the passage of the endoscopic tube. Occasionally by means of the urethroscope one may pass filiforms through an otherwise impassable stricture.

Diagnostic reliance on the grasping of the steel sound by stricture is advocated particularly by Keyes, and while bougies have little or no diagnostic value if the stricture is of filiform or fine calibre, sounds may have no value in diagnosing strictures of large calibre, not uncommonly observed lesions which may give rise to urethral symptoms—most often a chronic discharge.

Since the tendency to contract is the inherent characteristic of scar tissue, if the stricture is untreated, the clinical course is one of increasing severity. As there is no uniform rate of contraction, we find some strictures developing within a period of weeks; others are not clinically manifest within twenty years. The course is one of obstruction and infection, intermittent or continuous gleet, exacerbations of urethritis, an occasional periurethral abscess and, if the patient lives long enough, ultimate retention. A series of acute retentions may go unheeded until the final picture is that of complete chronic retention with overflow and continuous dribbling. The contraction rate of the scar on the one hand and the nature and extent of treatment on the other determine the course of the disease. Temporarily relieved, most patients neglect themselves; the lives of many are checkered with urethrotomies. One-fourth of our patients had had urethrotomy performed previous to the present admission and most of the others had followed an irregular course of sounds.

*Treatment.*—As recognized over three centuries ago by John Read,[4] the prophylactic or preventive treatment of stricture means proper management of the acute urethritis. Under-treatment is preferable to over-treatment. The urethral mucosa merits the same delicacy of therapeutic consideration as does the conjunctival mucosa.

Resorption of the inflammatory exudate common to chronic urethritis is best achieved by the passage of steel sounds. Many operators also employ the Kollman dilator. Dilatation acts as gentle massage and, by promoting congestion, stimulates the absorption of inflammatory exudate.

The non-operative treatment of stricture is dilatation, persistent and prolonged. It will cure a few and control all. A certain amount of inflammatory infiltration will be asorbed; formed scar will remain unless excised.

Gentleness and antisepsis are co-requisites. Of the two, gentleness is the more important. Asepsis of instruments and the hands is assumed. Instrumental trauma will aggravate and prolong a sub-acute infection. Gentle urethral instrumentation not infrequently stirs up a latent infection. This is best

combated by the introduction of antiseptics—1/5 per cent. silver nitrate or 1–1000 acriflavine after treatment. We have found, however, that if the patient cleanses the urethra by urination before instrumentation and again voids after, the danger of infection is minimized.

Local anæsthesia intraurethrally is advisable while the mucosa is still tender or until one determines the contour of this passage.

For further discussion of urethral instrumentation reference in the standard text is suggested. Of extreme interest is the first description of this technic. (Read.[3]) It is complete to the degree of dictating the use of filiforms, the relative position of patient and surgeon, and indicates clearly the phenomenon of urethral chill.

We found that of the 1244 cases admitted a third required no operation. They were dilated sufficiently (some under anaesthesia) and discharged to the out-patient department for continuation of treatment. Some of these showed no response to periodic dilatation and were referred back for operation. This failure to respond to dilatation is an indication for operation. It should be added, however,



FIG. 3.—Post-operative appearance of lesion like Figure 2. The stricture has been cut, perineal drainage tube inserted to bladder and anchored, genital and suprapubic gangrenous tissues incised widely for drainage. Testicles swinging freely. Recovery.

that a number of strictures were cut which might ultimately have yielded to gradual dilatation. For economic reasons and because so many of these patients are neglectful and careless of their best welfare, this immediate dilatation to maximum calibre by operation seemed advisable in many cases which otherwise would not have been operated upon.

In a measure, the site of stricture offers certain suggestions as to how it can best be treated. Stricture of the meatus should be cut. While well formed stricture of the pendulous urethra more frequently requires cutting as well as repeated dilatation, those of the bulb, unless complicated by active periurethritis, will usually respond to dilatation alone. Strictures of the deep urethra (membranous) are usually traumatic in origin, contract rapidly and require cutting. Periurethral abscess and impassable stricture each demand incision.

Internal urethrotomy on the roof of the canal is the indicated procedure if the stricture is in the anterior urethra, if it permits the passage of a filiform, and if there be no periurethral infection. External urethrotomy is performed chiefly in cases complicated by periurethral infection, for impassable stricture

or those which admit a filiform but not the urethrotome and for strictures of the deep urethra. In this series 848 patients were operated upon. Some were operated upon more than once while others had more than one type of operation performed at the same time. Internal urethrotomy was performed 143 times, external 433 times, combined external and internal urethrotomy 310 times. Other operations employed were *incision and drainage of associated periurethral abscess* 152, excision of urethral fistula ninety-five, suprapubic cystotomy twenty-seven, urethral resection five, and sounds passed under anæsthesia eight times. Forty-eight patients in whom operation was indicated refused this treatment.

*Anæsthesia.*—We have found that all forms of urethrotomy may be performed on the conscious patient. Seventy-one internal urethrotomies were done using novocain locally in the canal. Oddly, five of these subsequently died. Spinal anæsthesia is the anæsthesia of our preference for perineal section but it is only since 1920 that we have used this form of regional block with complete satisfaction. Prior to this all patients were given general anæsthesia. Recently[6] in comparing post-operative pulmonary complications in a group operated upon under ether and a group operated upon under spinal anæsthesia, we found the pneumonia ratio to be seven to one. Post-operative convalescence is *less stormy* with spinal anæsthesia and disturbing post-operative sequelæ fewer. For the past year we have been giving 50 mgms. of ephedrin sulphate intramuscularly fifteen minutes before the spinal injection. This has abolished alarming falls of blood pressure in all cases. If the initial injection of ephedrin does not sufficiently stabilize and support the blood pressure, it may be repeatedly employed without ill effect but we have never had reason to administer more than two injections. Caudal block was used eleven times. Three cases, moribund, had perineal section performed without anæsthesia. The types of anæsthesia administered and number of each with the group mortality are shown in Table IX.

TABLE IX.

*Anæsthesia 848 Cases.*

| Type | Number given | Deaths after | | Total deaths |
|---|---|---|---|---|
| | | Without extrav. | With extrav. | |
| General............. | 474 | 19 | 23 | 42 |
| Spinal.............. | 727 | 15 | 17 | 32 |
| Caudal............. | 11 | 0 | | 0 |
| Local.............. | 79 | 5 | 4 | 9 |
| None.............. | 4 | 3 | | 3 |
| Died without operation. | | 11 | 2 | 13 |

*Internal Urethrotomy.*—If the stricture is of filiform calibre the Maisonneuve instrument threaded to its whip filiform guide is passed. If the scar will permit passage of the Otis urethrotome this instrument is used. After

first cutting a filiform stricture with the Maisonneuve we introduce the Otis instrument and cut on the urethral roof to 35 F. so that a 30–32 F. sound may be passed to the bladder. An indwelling catheter attends to possible hæmorrhage and affords bladder drainage. As a rule, this is withdrawn the following day.

*External Urethrotomy.*—With the patient in lithotomy position under spinal anæsthesia, and with a small sound or filiform in the urethra as a guide the stricture is cut on the floor (at which time the vesicle neck may be palpated for irregularity or contraction), and a perineal bladder drainage tube anchored in place. In 158 of these patients, only a filiform could be passed to the bladder pre-operatively.

If the stricture has been found impassable, as in 157 cases, three avenues of approach are open. After injection of the canal with a half ounce of methylene blue for identification of the lumen, the perineal urethra may be (1) exteriorized by dissection and opened, (2) may be approached retrograde through the bladder by cystotomy as we did three times or (3) retrograde through the membranous urethra by perineal prostatic exposure following forward from the prostatic apex, as in two of our cases. With care and an accurate knowledge of perineal anatomy, one can usually contrive to enter the urethra by the first route. Once entered the stricture is cut and the bladder drained. Complicating anterior strictures are also cut. Often troublesome false passages in the pendulous urethra may be circumvented by passing the urethrotome retrograde from the perineal urethral opening. After performing a urethrotomy one should be able to pass a 30 F. sound without obstruction from meatus to bladder.

Associated periurethral abscesses are freely incised and afforded ample drainage. Rubber drains best keep these open although a gauze pack may be required to check obstinate oozing of the indurated tissues.

Complicating extravasation of urine demands inordinately wide incisions. We bisect the scrotum if necessary, perform extensive débridement of gangrenous tissues and incise widely to the boundary of healthy skin. If this is not done the gangrenous process continues, more tissue is involved, and a secondary operation required. Only half of those making a second trip to the operating room for extension of drainage incisions survive.

Post-operative care entails flooding the patient with water by mouth, rectum or hypodermoclysis. Fluid is life saving. We have given as many as four hypodermoclyses of over 1000 c.c. each in 24 hours. If the heart does not weaken there is little danger of waterlogging the patient. Digitalis is freely used under medical supervision.

As a rule the perineal tube is removed on the third day although badly infected bladders, poorly functioning kidneys or otherwise grave prognostic signs are indications for prolongation of this drainage. It will be found that many will become febrile with chills and other indications of sepsis on removal of the tube. If continued, this picture indicates replacement of the drainage. In two cases vigorous hæmorrhage followed removal of the perineal tube;

both required suprapubic cystotomy for evacuation of clots distending the bladder. Moreover, it is noteworthy that with this evacuation all bleeding ceases.

The passage of sounds is begun routinely on the seventh to tenth day post-operative and is continued every five days thereafter. Occasionally severe urethral chill with urosepsis will be observed; in such cases greater care must be exercised in future instrumentations. However, if benefit is to be derived from urethrotomy, it is imperative that dilatation begin after cutting of the stricture so that union of the incised band of scar may not occur and that such new post-operative scar as may be formed will be minimal.

*Post-operative Complications.*—Urosepsis is the most severe of post-operative complications and in our series was of greatest incidence. Clinical distinction between uræmia as a phase of renal dysfunction and generalized septicæmia of bacterial origin is sometimes quite impossible. As a rule the blood chemistry in the former will indicate marked nitrogenous retention and the culture of the blood in the latter often reveals a bacteriæmia. Free bladder drainage and high fluid intake offer the only hope of recovery in such an event.

Vigorous urethral hæmorrhage occurred ten times and required suprapubic evacuation of clots in five cases, in three of which only internal urethrotomy had been done. Firm application of a perineal packing under a tight binder will check some of these hæmorrhages if the posterior bulbous urethra is bleeding. The insertion of an indwelling catheter will stop hæmorrhage from the anterior urethra.

Pneumonia may result from inhalation anæsthesia or in the elderly may be of hypostatic causation. It is probably more often an embolic process. One patient with no pulmonary history and with negative chest findings pre-operatively was seized with a sudden voluminous hæmoptysis three days after operation. This subsided temporarily but recurred. The patient died. Although no autopsy was granted, we were unquestionably dealing with pulmonary embolism. Pneumonia was the immediate cause of death in eight patients. Myocarditis with clinical cardiac failure killed six. Intestinal paresis with enormous abdominal distention was fatal once.

Acute epididymitis followed operation in seven patients, abscess of the testicle occurred five times, periurethral abscess eight times, prostatic abscess three times and acute pyelonephritis was recorded seven times.

Many of these complications required additional operations. It is not uncommon to find that a urethra cut at operation to permit free passage of a 30–32 F. sound to the bladder will, when instrumented ten days later, be found exceedingly tight or even impassable. Because of this phenomenon, internal urethrotomy was repeated ten times, external twelve times. In six other cases the administration of an anæsthetic produced relaxation so that a previously tight or impassable channel was easily entered and dilated.

Incision and drainage of newly developed periurethral abscesses was necessitated twelve times. This usually means that the primary incisions were too meagre or that free drainage was otherwise blocked. Thirteen of 112 cases

of urinary extravasation secondary to stricture required extension of the drainage incisions, and in four of these extension of the phlegmonous process over the abdominal wall had occurred.

Cystotomy was performed for hemorrhage five times, for drainage incident to repair of perineal fistulæ eight times, and for prevesical abscess and the removal of a foreign body, each once. The foreign body removed was the broken-off head of a Pezzer catheter which had become heavily impregnated with lime salts, virtually forming a calculus. Vesical calculi were removed suprapubically in five cases.

The punch operation relieved associated prostatic obstruction once. Newly developed prostatic abscesses were drained three times.

Epididymotomy and epididymectomy were each performed once and orchidectomy five times. Very probably the suppurative process in some of these testicles was secondary to an unrecognized or neglected suppurative epididymitis.

Urethral fistulæ were repaired eleven times; urethro-rectal fistulæ once. In two cases of extensive urinary extravasation due to stricture, a penile plastic repair with skin graft was performed. (Fig. 4.)



FIG 4 —Use of Thiersch grafts to accelerate genital cutaneous repair. Satisfactory end result.

The recital of the relative frequency of the complications in such a large series of cases affords more actual information regarding post-operative possibilities in stricture surgery than a descriptive essay. Experience has taught that irrespective of an excellent prognosis, post-operative convalescence is fraught with numerous undesirable potentialities. One patient, well recovered from the operation and nearly ready for discharge from the hospital, developed urethral chill and metastatic cerebrospinal meningitis following the passage of sounds. He died. The prognosis in all cases therefore must be guarded.

Ten hundred and ninety-three of these patients were discharged as improved, nine were unimproved, thirty-six left at their own risk and ninety-nine died. Forty-four of these deaths occurred in a group of 112 cases complicated by urinary extravasation. Of the ninety-nine fatalities, thirteen were in unoperated patients. These were either admitted in coma and died before operation could be performed, or sick on admission; they refused surgical treatment.

Though discharged as improved, the urethræ of 276 patients would admit a sound no larger than a 25 F. In two of these, with impassable stricture pre-operatively, a filiform only could be passed at time of discharge. Often severe renal infection and "urethral fever" following instrumentation defers one from the systematic periodic passage of sounds. During the protracted interval great contraction of the old stricture with formation of new scar ensues. The urethra of a patient of mine, will regularly contract in a period of three weeks from 20 F. to filiform calibre. Many such urethræ will be benefited if not actually cured by resection of the scar, and end-to-end anastomosis. In one of five cases so operated upon in this series, 5 cm. of urethra was removed with good result.

Perineal leakage may persist for some weeks following external urethrotomy but in most instances represents but a phase of persistent obstruction. With full dilatation of the canal these fistulæ will rapidly heal if the tract is curetted occasionally and granulations destroyed.

Urinary incontinence following external urethrotomy means probable injury to the external sphincter. Partial incontinence followed external urethrotomy in four cases.

*Prognosis.*—In a large group of cases such as this, subsequent histories offer a broad prognostic index. Ninety-nine or 7.3 per cent. of all cases died. The operative mortality exclusive of extravasation cases was 4.9 per cent., inclusive of these 10.1 per cent. It is noteworthy that of stricture cases complicated by extravasation over half terminated in death (54.2 per cent.). (Table X.)

TABLE X.

*Mortality.*

Total mortality—all cases.................................................. 7.3%
Total mortality—operative cases including those with extravasation............ 10.1%
Without extravasation....................................................... 4.9%
Mortality extravasation—stricture cases..................................... 54.2%

Clinical follow-up is so unsatisfactory among charity hospital patients, especially in a large city, that consideration of the pre-operative history best indicates what we may expect subsequent to our operative treatment.

A few will probably be cured. The majority will pursue an irregular course of sounds, during the increasing lapses of which sclerosis will intensify. The vicious cycle of contracting scar with increasingly painful instrumentation prompting longer intervals between dilatation, and again more scar, will ensue. While this is going on, intercurrent flareups of urethritis, prostatitis

or periurethral abscess will serve but to aggravate the fundamental lesion. These patients may weather several acute retentions, many will become incontinent by overflow from a chronically distended bladder, a few will develop urinary extravasation and within the period of a few years over a third of the entire number will require reoperation. Of this relapsing group, a fourth will require reoperation within two years, and two-thirds within ten years. Of our patients twenty had been operated on twice previously for stricture, seven three times, two four times, one seven and another nine times. (Table IV.)

SUMMARY

1. Urethral stricture in the male is of prime importance among surgical lesions of the urinary tract.

2. A detailed study of twelve hundred and forty-four cases of stricture is reported.

3. Over 90 per cent. of urethral strictures are of inflammatory origin; nearly all follow gonococcus urethritis. Though gonorrhœa be denied by the patient, the gonococcus will be sometimes revealed by careful examination.

4. Since columnar and cylindrical epithelium favor gonococcus growth and squamous epithelium is resistant to this infection, inflammatory stricture is common to the anterior and bulbous urethra but rarely found in the membranous portion. The latter, however, is the site of most traumatic strictures, the straddle injuries of the perineum.

5. Improper treatment of the antecedent urethritis accounts for most gonorrhœal stricture even though the lesion may give no symptoms until twenty years later.

6. Stricture depends on the severity of the urethritis rather than on the duration.

7. The majority of inflammatory strictures are clinically multiple though pathologically they may be single. Traumatic strictures are usually single.

8. Nephropathy secondary to stricture obstruction is of prime concern. We consider and treat stricture on the basis of renal damage and infection.

9. Prognosis rests on renal function and broadly speaking is proportional.

10. The symptoms of stricture are varied and may be present many years before acute local inflammation precipitates search of medical relief. Alteration in the size of the urinary stream, terminal dribbling, dysuria, frequency of urination, hæmaturia, and an intermittent gleet are perhaps most commonly observed. Acute retention may be the first symptom noted.

11. Associated complicating inflammatory lesions are frequently observed.

12. Diagnosis of stricture rests upon grasping of an urethral instrument by the scar. The most accurate diagnosis is afforded by eliciting the "hang" as an olivary bougie is withheld by the scar; a jump is felt as the bulb is pulled through the stricture.

13. Urine shreds are always present with stricture; urinalysis frequently discloses blood.

14. Estimation of the non-protein nitrogen and creatinin content of the blood and the two-hour phenolsulphonephthalein test (intramuscular route) have been the function tests employed.

15. The preventive treatment of stricture lies in proper treatment of urethritis.

16. Dilatation constitutes the non-operative or palliative treatment. Its employment must be persistent and prolonged.

17. Failure to respond to dilatation and certain complicating infections are the indications for operation.

18. By internal urethrotomy strictures of the pendulous urethra and scrotal bulb are cut. An indwelling catheter provides bladder drainage and checks bleeding.

19. For deeper strictures perineal section must usually be performed. When this is done, a perineal bladder tube should always be used.

20. Extensive multiple strictures may require both external and internal urethrotomy.

21. Spinal anæsthesia is the anæsthetic of our choice for urethrotomy.

22. Preservation of free urinary drainage, free evacuation of the bowels, and forced fluid intake sums up the immediate post-operative care.

23. Dilatation with sounds beginning seven to ten days after urethrotomy and continuing every five to ten days thereafter until the canal maintains a normal calibre, should be performed with rare exception.

24. Numerous post-operative complications may develop, many of which are potentially fatal. The most important of these are urosepsis, hæmorrhage and pneumonia. Localized suppurative processes require incision and drainage.

25. While the immediate mortality (excluding cases of urinary extravasation with a 45 per cent. mortality) is about 5 per cent., most patients are improved by operation; but one-third will require reoperation, two-thirds of these within ten years.

26. Foremost in the consideration of all urethral instrumentation is gentleness. Actually it is of greater importance than asepsis.

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# URETHRAL STONES

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The lodgement or development of concretions in the urethra is of unusual but by no means rare occurrence. It has been of importance in seven of the 2,900 urological cases in my practice. Ordinarily the canal is large enough to permit the passage of any object that is small enough to gain entrance to it at the vesical orifice, and the development of stones here is quite unusual. This is particularly true of the female, in whom the urethra is short, straight and of a comparatively large calibre, whereas in the male the natural curves and normal narrowings as well as strictures that may be present rather favor the arrest of any body passing through it.

Ordinarily the lodgement of a stone is preceded or followed by symptoms that draw the attention of the patient to the condition and make him seek relief at once. This is not always true, however, for instances of stones having remained in the urethra for twenty years have been recorded, and the removal of specimens that show polished facets, in positions that could only be the result of long-continued coaptation in the location in which they were found, proves that they must have been there for long periods.

They are spoken of as *primary* when they have their origin in the urethra and as *secondary* when they are arrested there after having been formed and set loose elsewhere. Evidence that is unquestionable of the primary nature of any given stone is very difficult to secure unless it happens to have been formed about a foreign body. The fact that a stone is found in a urethral diverticulum or behind a stricture does not speak conclusively for its being primary. An irregularly laminated structure indicates that the stone may have increased in size by successive deposits of salts which are usually thickest in a direction closest to the bladder.

Their color, consistency, and shape vary with their chemical composition, the parts with which they have been in contact and the length of time they have been in the canal. The size is also variable, some as large as nine centimetres in diameter and weighing as much as 390 grams having been reported.

They may be found in any part of the urethra but are most common in the prostatic position. Englisch gives the following percentages in 361 reported cases collected: Fossa navicularis, 11; penile portion, 15; scrotal, 14; bulb, 19; prostatic, 41.

They are usually single but may be multiple, as many as 230 having been reported by Civiale in the posterior urethra.

The symptoms are quite variable and variegated. Perhaps the most common is a sudden stoppage of urination during the act, followed by retention or by dribbling which may or may not be relieved spontaneously. If this has

been preceded by an attack of renal colic and if a small kidney or ureteral stone is known or suspected to be present, the diagnosis is generally simple. Without such a history, however, the symptoms may be confusing. Once a stone has lodged in the urethra, more or less inflammation is set up which will be stubborn unless the cause is recognized and relieved. In some instances the patient comes under observation with extravasation of urine, the stone having caused ulceration and gangrene of the urethra and the stone noted as an incident in operations for the relief of that condition. Some patients bear their difficulty for long times without seeking relief, using various means such as moving the stones about by pressing on the perineum, drawing downward on the scrotum and testicles, etc., to make urination possible.

In a frank case with history of renal colic or of stone followed by sudden stoppage of the stream of urine, the diagnosis is generally easy. A nodule may be palpated along the urethra at the site of lodgement and an obstruction to the passage of an instrument noted at this point. Crepitus may be noted if the stones are multiple. The typical click may be secured if the instrument used is of metal. The diagnosis may also be made by finding scratches on a bougie coated with wax. The X-ray will also be of service.

The treatment must be varied to suit the case and will depend upon the location and size of the calculus as well as upon complications that may be present. The simplest procedure that will effectively remove the calculus should be used, and the ingenuity of the surgeon will be sometimes taxed to devise a method that will do away with the necessity for a cutting operation. In general, the object is to pull out, push back or break up the calculus.

In the fossa navicularis a simple meatotomy will generally enable one to push the calculus out by external pressure or to remove it in the grasp of forceps.

In the penile urethra the passage of several filiforms about the stone and simultaneous withdrawal of them may effect removal or the stone may be grasped with a forceps through a urethroscope. The stone may be withdrawn in the grasp of one or other of the various instruments devised for the purpose of dislodging ureteral stones. If a stricture is present, its division by internal urethrotomy should precede other manipulations. Various forceps devised for grasping stones may be used with more or less success. In general it is best to avoid crushing the stones on account of the danger of leaving fragments behind and because of the possibility of seriously wounding the urethra. With stones of any considerable size in the bulb minor measures are apt to fail and make an external urethrotomy necessary.

Other things being equal, the prospects of success with minor measures are lessened the deeper the stone is in the urethra. If extravasation is present a perineal section should, of course, be done at once.

If the stone is large enough to obstruct and is in the prostatic urethra, the passage of a sound may force it back into the bladder, after which it may be treated as a bladder stone. Multiple stones in the prostatic urethra are

generally complications of a lesion of the posterior urethra and their removal only incidental to the treatment of that condition.

CASE I.—No. 215, F. W. M., age legal, housewife. During previous ten years had had five abdominal operations for relief of vague abdominal pains; had never been X-rayed or cystoscoped. Sudden obstruction to urination during the act followed by complete retention. Patient refused · to be catheterized and retention was gradually
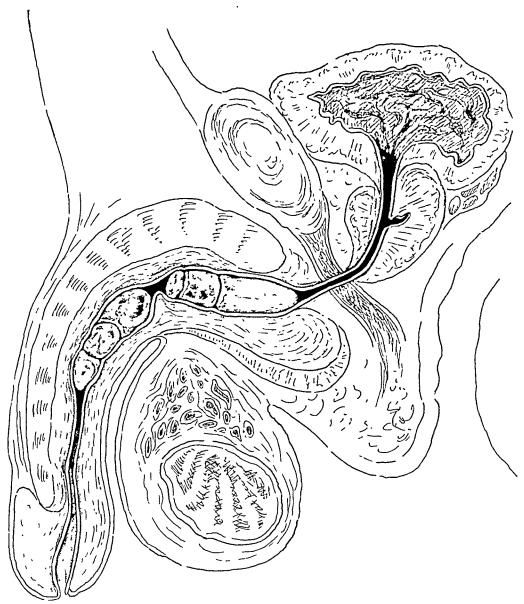


FIG. 1.—Calculi impacted in urethra. (Case VI of text.)

relieved. One month later she developed tumefaction at the side of the urethra and consulted a physician who referred her to me.

Examination showed a small mass just back of the urinary meatus. There was a marked non-specific urethritis and two openings of an abscess at either side of the urethra. The bladder urine obtained on passing a No. 18 F. catheter was clear. On trying to pass an endoscope a click was noted, but she was so tender that she refused further manipulation.

The diagnosis of impacted stone in the urethra was made and confirmed by a letter from her a month later. A "large stone" had been removed by Doctor Lewis, of Cleveland, with complete relief of symptoms.

CASE II.—No. 1149, M. W. M., age seventy years, sailor. Rough calculus 3.0 millimetres in diameter encountered just back of meatus on attempting to catheterize for relief of obstruction due to prostatic adenoma. Stone removed with artery forceps and prostatectomy accomplished without complication.

CASE III.—No. 1929, M. W. S., age twenty-nine years. Patient with left ureteral stone. Felt stone pass into bladder and later along urethra during urination and stop at meatus, after which very little urine could be passed. Rough, irregular calculus 10 x 5 x 3 millimetres removed by meatotomy.

CASE IV.—No. 2565, M. W. S., age fifteen years. History of "nephritis" for four years. Clears up at times but when quite normal has nocturia of two. Has passed stones at intervals and recently one stuck in urethra but was passed later.

Present attack came on four hours before as stoppage during urination followed by complete retention. Small nodule palpated at midpoint of penile urethra at point at which obstruction to catheter occurs. After various manipulations, three stones were removed in the grasp of a spiral ureteral stone dislodger. Patient died of uræmia eighteen days later and necropsy revealed bladder and bilateral renal tuberculosis.

CASE V.—No. 2107, M. W. S., age twenty-seven years. Bilharziasis at fifteen years. Difficulty of urination four months ago. For past twenty-four hours has had pain in hypogastrium. Painful frequent urination and terminal hæmaturia.

Catheter arrested at bulb and pressure causes great pain. Waxed-tipped filiform shows scratch marks. X-ray shows stone 1.0 centimetre in diameter in bulb.

Stone pushed into bladder on passing sound preparatory to external urethrotomy and was later removed by crushing with a Young rongeur. Convalescence uneventful.

CASE VI.—No. 2614, M. W. M., age sixty-five years. Incontinence of urine and hæmaturia for six months past. Nocturia two to three for two months.

Palpable masses that crepitate extend from midpoint of penile urethra to bulb. X-ray shows a series of five to six urethral stones, a large stone in the left ureter and a small one in the left kidney region. Six urethral stones depicted removed by external urethrotomy through two urethral incisions from single perineal wound. Later removal of prostatic adenomata.

CASE VII.—No. 2789, M. W. M., age forty-six years. Previous gonorrhœa. Recent retention of urine relieved by catheter which was left indwelling. Crepitus noted in prostate on rectal examination. X-ray shows prostatic stones. Round stone 4.0 millimetres in diameter in eye of Malecot catheter removed preliminary to cystoscopy. Prostate inflamed and contains stones but is not adenomatous.

# EXTRAARTICULAR ARTHRODESIS OF THE HIP FOR TUBERCULOSIS *

## WITH A REPORT OF 31 CASES

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BRISTOW, in a recent article on Arthrodesis in the *British Journal of Surgery* refers to extraarticular arthrodesis of the hip as "a recent innovation". This statement is somewhat surprising, as the author did an extraarticular arthrodesis of the hip in 1913, and reported a series of cases, describing the technic in detail, in 1919. Julius Hass reported his technic in 1922. The Hibbs' procedure. which is very similar to that of Hass, was presented by Farrell in 1925 and Hibbs in 1926. Neither the Hass nor Hibbs technic is completely extraarticular.

Tuberculosis of the hip is a condition most unfavorable to intraarticular arthrodesis, either spontaneous or operative. The reasons for this are obvious: (1) Inhibition of osteogenesis by the tubercle bacillus; (2) the peculiar anatomy of the joint frequently causing recession of bone surfaces from each other as bone destruction progresses, or following intraarticular removal of bone by the surgeon for arthrodesis purposes, because of the ball and socket contour of the hip-joint (peripheral destruction of the femoral head causes it to become smaller, whereas peripheral destruction of the acetabulum causes it to become larger). Also, because of the anatomy and mechanical relationships of the hip and pelvis, as extensive destruction of bone progresses the diseased bony surfaces of the femur and pelvis do not tend to approximate because of impingement of the inside of the trochanter against soft parts at and above the rim of the acetabulum. Since the tubercle bacilli inhibit the active osteogenesis which would normally take place, dead spaces filled with caseous material are left between the bony elements, and spontaneous ankylosis and cure become improbable. Even if intraarticular arthrodesis is attempted, the impossibility of removing all tuberculous material, and the possibility of causing metastatic infection or sinuses with secondary infection, the low osteogenetic potentiality of the bony elements of the joint, and the consequent failure to secure fusion render the operation untrustworthy.

Bracing in cases of extensive destruction and caseation, largely for the same reasons, has been signally unsuccessful.

Extraarticular arthrodesis, first used by the author in 1913, and described in 1919,[1] is a most satisfactory alternative. By strongly bridging the joint with a tibial, femoral or iliac graft or grafts mortised into the bony elements on both sides of the joint, complete fixation is secured. The immobilizing

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influence of union of the femur to the pelvis makes it unnecessary to enter the infected area.

This operation has now been used by the author in thirty-one cases with very satisfactory clinical and functional results in all cases. (Table I.) In each case X-rays taken a few months after operation show the grafts firmly in place, and those taken several years later reveal marked proliferation and illustrate well the strong bridging support which this type of extraarticular
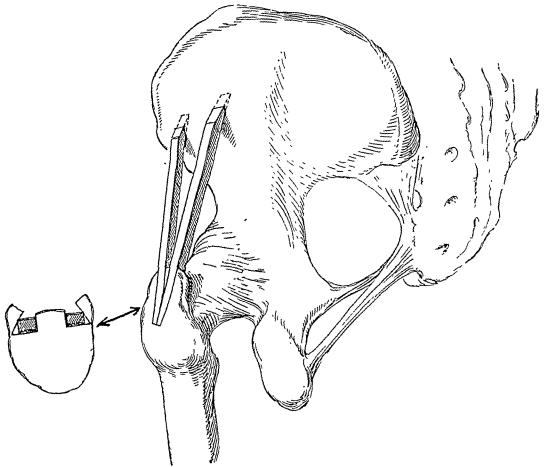


FIG. 1.—Technic for extraarticular arthrodesis, in cases where destruction is moderate. Tibial grafts are carefully mortised into the great trochanter and the side of the pelvis, forming a strong bony bridge. (Group 1a.)

arthrodesis affords. (Fig. 1.) These cases have been followed from one to twelve years post-operatively, with an average of six and one-half years.

### FOUR VARIATIONS OF TECHNIC ADAPTED TO VARYING DEGREES OF DESTRUCTION

In an extensive experience with extraarticular arthrodesis of the hip during the past thirteen years, the author has been convinced more and more that it is distinctly advantageous to the surgeon to have more than one type of operation to select from in meeting the variety of mechanical requirements which I have above discussed. Any proposed extraarticular arthrodesis is best brought about between the great trochanter on one side of the joint and the side of the ilium just above the rim of the pelvis on the other, and since the proximity of the trochanter to the side of the pelvis and the

rim of the acetabulum varies widely in accordance with the degree of joint destruction, limb adduction and flexion, the operative technic must vary accordingly. As in every surgical procedure, the simplest technic associated with the minimum of trauma and shock to the patient should be chosen, and also one which will the least interfere with a future arthroplasty, should the latter be desired and prove feasible. (See Case 7.)

From the technical standpoint cases suitable for extraarticular arthrodesis of the hip can be divided into two groups, on the basis of pathological
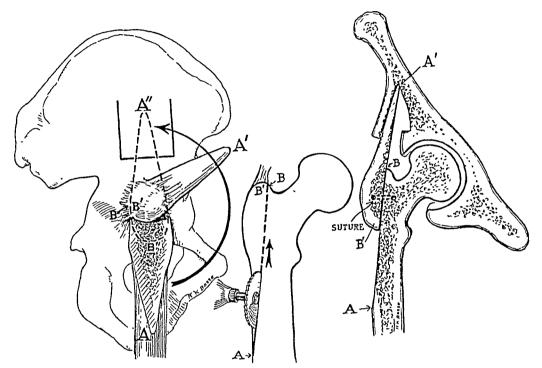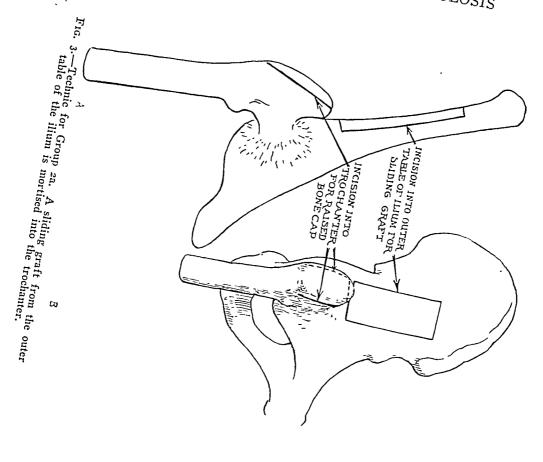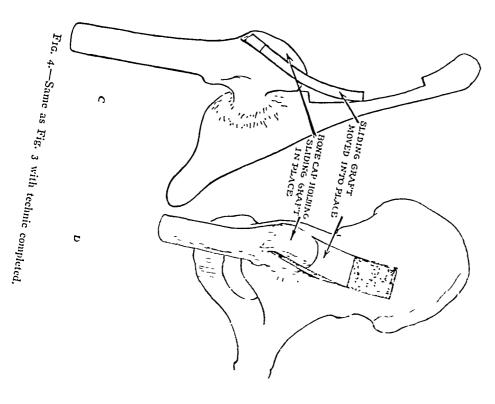


Fig. 2.—Technic for Group 1b. Hibbs or Hass technic modified so that it is really extraarticular.

findings, and each of these subdivided into two types, as to the character of operation.

*Group 1.*—In the first group the destruction is moderate in amount and the great trochanter remains widely separated from the side of the pelvis, so that a bone graft cannot be obtained from the side of the ilium or the immediate locality in sufficient length and strength to serve as a bridge for the extraarticular arthrodesis. Therefore the surgeon is compelled to go to the tibia or the outer portion of the upper end of the femur for graft material, because of the necessity of obtaining not only long but strong grafts.

*Operative Technic for Group 1a.*—The patient is anæsthetized to muscular relaxation and placed upon the fracture-orthopædic table. The surgeon forcibly corrects the adduction of the diseased hip by manual counterpressure, placing one hand against the buttock and the other against the inner aspect of the knee. His assistant at the same time, by adjusting the fracture-orthopædic table, places the well leg in the limits of physiologic abduction, and cautiously swings into a position of abduction the traction

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FIG. 3.—Technic for Group 2a. A sliding graft from the outer table of the ilium is mortised into the trochanter.

INCISION INTO OUTER TABLE OF ILIUM FOR SLIDING GRAFT

INCISION INTO TROCHANTER FOR RAISED BONE CAP

A

B

FIG. 4.—Same as Fig. 3 with technic completed.

SLIDING GRAFT MOVED INTO PLACE

BONE CAP HOLDING SLIDING GRAFT IN PLACE

C

D

FIG. 6.—Same as Fig. 5 with technic completed.

Labels in Fig. 6: BONE FLAP RAISED; TROCHANTER SLIPPED INTO NOTCH; CENTER OF ROTATION

Labels in Fig. 5: INCISION INTO OUTER TABLE OF ILIUM FOR BONE FLAP; CENTER OF ROTATION; EXTENT OF DENUDATION OF TROCHANTER

FIG. 5.—Technic for Group 2b. This is applicable only in rare cases in which the trochanter is practically resting against the side of the ilium, and all tuberculous tissue has been previously removed during unsuccessful attempt at intraarticular arthrodesis.

arm of the table holding the diseased leg. The amount of abduction in which the latter is placed depends upon the amount of bony shortening. This method of correction, partly by mechanics of the table and partly by manual pressure, is adopted in order to guard against overstretching the lateral ligaments of the knee-joint.

A somewhat curved incision starting at the crest of the ilium, two inches posterior to the anterior-posterior spine and carried down below the great tro-

chanter, is made through the skin. The gluteal muscles are separated sufficiently to expose the side of the ilium at the points of mortise for the insertion of the proposed tibial grafts.

Because of the thinness and elasticity of the bone comprising the outer table of the ilium, a mortise suitable to receive the grafts can be satisfactorily made with a half-inch chisel driven through the outer table of the ilium obliquely upward between it and the inner iliac table, with the handle of the chisel in close proximity to the trochanter. With the cutting end of the chisel still in the mortise prepared by it, located one inch posterior to the anterior-superior spine, and



Fig. 7.—X-ray taken eight years after operation (Case I). Note proliferation of tibial grafts, especially at trochanter end where mechanical stress is greatest. When inserted the grafts were the same diameter throughout. This patient was operated on thirteen years ago and the result is excellent.

one inch below the crest of the ilium, the handle is depressed onto the outer surface of the trochanter at its anterior border, and used as a guide for some cutting tool, such as the scalpel, to mark on the periosseous structures the line where the motor saw is later to prepare a gutter for graft No. 1.

The same preparation is made for graft No. 2, except that the mortise in the ilium is made about one and one-half to two inches posteriorly to the first one, and the scalpel mark is made on the posterior outer surface of the great trochanter.

Saw cuts are now made one-half inch in depth with the motor saw, fol-

lowing the scalpel marks just made on the trochanter. With an osteotome driven into these saw cuts, fragments of the trochanter are displaced with the periosseous soft parts as hinges, anteriorly from the saw cut for graft No. 1 and posteriorly from the saw cut for graft No. 2, so as to produce gutters to receive the two grafts.

The anterior internal surface of the tibia is then laid bare from the tuberosity of the tibia downward. With the motor twin saw set with the blades approximately five-eighths of an inch apart, a graft is removed by saw cuts made downward from the tuberosity of the tibia about nine inches. With a small motor saw, this strip of bone is then cut into two segments. The upper ends of the grafts are cut in an oblique way like the end of a chisel.

The upper end of graft No. 1 is inserted into the mortise of the ilium with its lower end lying in the anterior gutter prepared in the trochanter. The oblique surface at the upper end is outward. With the author's bone drift or set (of which the carpen-



Fig. 8.—Post-operative X ray, Case II.

ter's nail set is the prototype) placed on the trochanteric end of the graft, the graft is now driven into the iliac mortise. (Fig. 1.) In this manner its trochanteric end is made to slide along the trochanter gutter and its proximal end to penetrate the mortise of the ilium by means of blows of the mallet upon the bone set.

Graft No. 2 is put in by precisely the same technic. The firmer the grafts are driven into the iliac mortise, the closer do they hug the bottom of the trochanteric gutter because of the obliquity of the cut end of the iliac end of the graft. This plan of operation automatically immobilizes the grafts at both ends in a most gratifying way and no immobilizing bone ligatures are necessary. (Fig. 1.)

The soft parts with fragments of the trochanter are drawn over the ends of the graft by means of interrupted strands of medium kangaroo tendon. The gluteal muscles are carefully drawn about the grafts by means of chromic catgut sutures.

The skin is closed with continuous suture of o plain catgut. Suture holes and the edges of the wound are puddled with three and one-half per cent. tincture of iodin.

*Technic for Group 1b.*—The upper portion of the approach for this procedure is very similar to that described when tibial grafts are used. In this instance the incision must extend generously downward so as to give free exposure of the antero-external aspect of the upper end of the femur (extending downward from the tip of the trochanter for five inches). The soft structures are separated, leaving the periosteum on the femur. With the motor saw and sharp one-half-inch osteotome, a strong graft about five inches long and comprising about one-fifth the diameter of the shaft of the femur from the tip of the great trochanter downward is obtained with a pedicle of muscle at its upper end. The lower end (See Fig. 2) of the femoral graft is now swung anteriorly on the muscle and soft tissue pedicle at the upper end as an axis until its anterior end comes in contact with the side of the ilium. When the desired location on the ilium is thus determined a flap or door of the outer table of the ilium is turned
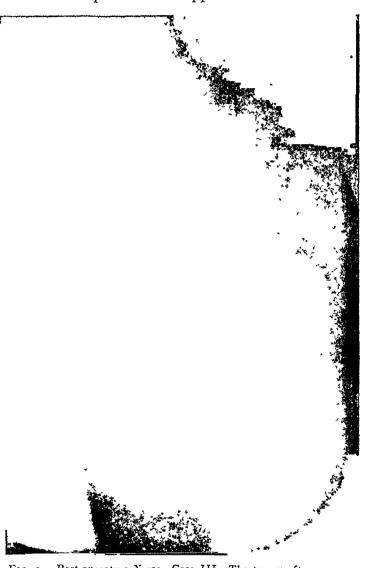


Fig 9 —Post operative X ray, Case III. The two grafts are superimposed so that only one is apparent.

slightly upward and backward by means of the motor saw and half-inch osteotome, so that the upper end of the graft (formerly the lower end) can be thrust backward beneath it. (See Fig. 2.) Bone fixation ligatures are not necessary, as when the graft is jammed with a few blows of the mallet and bone drift it is firmly placed and will not be displaced. The muscles and fasciæ are now replaced over and around the graft with continuous suture of chromic catgut, and skin closed in the usual way.

The Hass or Hibbs procedure is somewhat similar to this method,

except that Hibbs' method is not truly extraarticular, as both his diagrams and the description of his technic show that the neck of the femur is exposed and the cortex removed. The operation is therefore necessarily within the tuberculous area, which is to be avoided. Furthermore, it requires an extensive operative field, wide resection of muscles, and much shock. One should recall in this connection Cannon's findings that extensive muscle trauma is a most potent influence in producing shock. The procedure is the most difficult of the four types of technic presented. The author has so modified this operation that it is extraarticular, but the great trochanter and attached muscles are much more damaged than when the tibial grafts are used, and leaves more unfavorable conditions for a future arthroplasty—a possibility which should always be borne in mind in planning an arthrodesis. (See Case 7.)

*Post-operative Dressing.*—Extensive dressings of gauze and sterile cotton are applied, and then a plaster-of-Paris spica from above the costal



Fig 10 —Post operative X ray, Case IV.

margin to the base of the toes on the operated leg, and to below the knee-joint of the opposite leg, in a posture of abduction sufficient to overcome practical shortening.

With the plaster still in a semi-plastic state, it is carefully molded over the operated area, for two purposes: to favor immobilization, and to aid in the control of bleeding.

The plaster on the uninvolved leg is removed at the end of five weeks. The remainder of the plaster is left alone until ten weeks from the time of operation.

*Technic for Group 2a and b*—Group 2 is illustrated by Figs. 3, 4, 5, and 6. The head and a large portion of the neck of the femur have been disintegrated with telescoping, causing the trochanter to become more or less closely approximated to the superior rim of the acetabulum and the side of the pelvis.

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For convenience in discussing the operative technic this group may be subdivided into two types:

*Group 2a* comprises those cases in which the destruction has been so extensive that the trochanter has approximated the rim of the acetabulum to a sufficient degree—within one-half inch or less—so that a sliding graft from the outer table of the ilium (Fig. 3) is adequate to reach from the side of the ilium into the trochanter and also furnish adequate contact with

these bony elements and still allow the surgeon to keep outside the tuberculous joint. The side of the ilium 'has already been laid bare by the Smith-Peterson approach and furnishes a very satisfactory graft in that this outer table is not only curved so that it approximates the trochanter and ilium satisfactorily (Fig. 4), but also enables the surgeon to secure as broad a graft as he wishes. This technic is somewhat less difficult of execution and consumes less time than obtaining a graft from the tibia or femur, as described under Group 1. The surgeon, after sizing



Fig. 11.—Post-operative X-ray, Case VI. Note complete absence of head and neck, both because of destruction by disease and operative removal at previous unsuccessful attempt at intraarticular arthrodesis by prominent orthopædic surgeon.

up the mechanical conditions, may therefore choose this type of technic rather than the other two already described.

In certain extreme cases, Group 2b, in which the trochanter is practically resting against the side of the ilium, and in which an intraarticular arthrodesis has been previously attempted, with complete removal of all tuberculous tissue, the following simple technic may be used: The trochanter may be denuded of its periosteum and periosseous structures, both on its outer and inner surfaces. The outer table of the ilium just above the acetabular rim is then lifted externally, and the denuded trochanter implanted beneath the latter by swinging the hip into the abducted posture which automatically elevates the trochanter into the crevice thus made. (Figs. 5 and 6.) It may be necessary to supplement this procedure by implantation of a graft obtained from the outer table of the ilium, higher up near the crest. These very extreme cases are rare; the author has encountered only two of this type. This technic is partially intraarticular.

In any event one should design the operative procedure so that the graft used will be firmly mortised into both femur and pelvis without entering the tubercular joint, and it will have to be left to the judgment of the surgeon as to just what technic should be chosen, always remembering that the simplest technic feasible will be most satisfactory.

Either of the procedures described under Group 2 is easier of execution than those for Group 1, providing the trochanter is near enough to the side of the pelvis so that it can be well carried out.

*Indications for Operation.*—Extraarticular arthrodesis is indicated, preferably in older children or adults, (1) whenever there is constant relapse of the abduction deformity in spite of conservative measures to overcome it. such as traction in bed, braces, etc., after long periods of such treatment. (2) If the abduction deformity recurs following Gant's osteotomy, because of the hip not being completely ankylosed. (3) If the X-ray reveals marked destruction of the head or acetabulum, or both. (4) If there are symptoms of active tuberculosis. (5) In adults even if the bone destruction is moderate. The advantages of extraarticular arthrodesis for advanced tuberculosis of the hip with destruction is well illustrated by the author's first case.



Fig. 12.—Post-operative X ray, Case VII Arthroplasty four years after arthrodesis by technic 1a Note grafts from previous arthrodesis

*Relative Difficulties of Technic.*—The simplest technic is 2b, but for the reasons already discussed it is applicable only in rare instances.

Where the great trochanter is in close proximity to the rim of the acetabulum, the simplest bone-graft operation possible for extraarticular arthrodesis is applicable: the sliding down of a broad graft from the outer table of the ilium into the split trochanter (2a).

The tibial grafts (1a) are next in order of difficulty.

The most difficult operation, particularly as to extent of operative field and tissues involved, is 1b, the modification of the Hass or Hibbs technic. The original Hass-Hibbs operation is not extraarticular, but about four or

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five inches of the outer portion of the great trochanter and the shaft of the femur can be used to accomplish an extraarticular arthrodesis. This, however, is an operation of great magnitude in that an incision has to be made from just below the crest of the ilium to nearly one-third down the thigh in order to rotate the graft into position (Fig. 2).

*Caution.*—A word of caution concerning the execution of bone-graft technic is stimulated by recent observation of a lantern slide reproduction of post-operative results elsewhere, in which it was claimed that extraarticular arthrodesis of the hip had been accomplished, but with unsatisfactory results in a considerable percentage. The X-rays in the slides showed that the same inadequate and imperfect technic had been practiced as has been so frequently observed during the past eighteen years when certain surgeons have drawn unfavorable conclusions from their attempts to accomplish extraarticular arthrodesis of tubercular spines, although the operative technic was inadequately carried out. At one of our largest university medical schools a few years ago post-oper-



Fig. 13.—Case VII. Functional result following arthroplasty of hip four years after arthrodesis.

ative X-rays of nine grafted tubercular spines in children were shown. In only two of these cases were the grafts long enough or properly inserted. Nevertheless deductions were drawn from the nine cases, as to the efficacy of the bone graft in the treatment of tubercular spines. Therefore the author wishes to emphasize the necessity of the graft being of sufficient strength, ample length, accurate fit, and carefully mortised on either side of the joint if good results are to be secured. Carelessness in technic will obviously have a marked influence on end results.

ILLUSTRATIVE CASES

Case I.—The patient (J. L.), a woman forty-three years of age, was first seen by me May 25, 1910, and presented all the symptoms of a typical acute tubercular hip on the right side. X-rays taken at that time confirmed the diagnosis.

The patient was immediately fitted with a Phelps brace with a high shoe on the left foot, and crutches. This brace served to immobilize and to relieve the hip from weight-bearing. It was worn for two and one-half years and then removed; but because of pain, the patient was unable to get along without it, and so the brace treatment was resumed.

In October, 1915, the patient claimed that her symptoms were more severe than when we had begun the brace treatment five years before. X-rays showed considerable destruction of the acetabulum and head of femur.

During this whole period the writer had been producing an extraarticular arthrodesis of the spine by inserting autogenous bone grafts into the spinous processes, with excellent results. It therefore occurred to him: "Why not apply the same principle to the tuberculous hip where the mechanical, pathological, and surgical difficulties of intraarticular arthrodesis are so great?" The matter was discussed with the patient, and she was perfectly willing to undergo such an operation.

October 30, 1915, at Postgraduate Hospital, New York City, the operation was done under a general anæsthetic, with the patient on the fracture-orthopædic table. After the adduction had been corrected, two strong tibial grafts (each about four and one-half inches in length and five-eighths inch in width) with the full thickness of the periosteum, cortex, and whatever marrow substance clung to the graft (Fig. 1) were mortised into the side of the pelvis and into the trochanter, the grafts coming together at the trochanter like the rafters of a pitched roof. These grafts were obtained with the author's twin-motor saw. One long graft was secured from the antero-internal surface of the tibia with the twin saw, and cut in the middle to provide two grafts.



FIG 14 —Same case as Fig 13.

Upon discharge from the hospital the patient was immediately admitted to the Burke Foundation Convalescent Home at White Plains, N. Y. Although she had had a very stubborn tubercular hip, she made such an excellent recovery that she was taken on as a practical nurse and helper at the Convalescent Home. A letter received from her in the spring of 1926 indicates that the result is brilliant. She stated that she was still working as a nurse, and had no symptoms in her hip whatsoever. These grafts were obtained from the tibia with the twin-motor saw, and when obtained were of the same diameter throughout.

The X-ray (Fig. 7) ten years after insertion of the grafts demonstrates in a very striking way the influence of stress upon their growth. Inasmuch as the nearer the trochanter, the greater the stress, the grafts have become conical in shape with the largest diameter near the trochanter.

CASE II further illustrates the advantages of this treatment. A young woman (H. F.), aged eighteen years, consulted me in September, 1920. For ten years she had been suffering from a tuberculous hip. In 1914 symptoms disappeared but left the limb in a marked adducted posture with incident shortening. To relieve this she was taken to a hospital in 1916, and, under an anæsthetic, the adduction overcome and a plaster-of-Paris cast applied, which she wore for three months. Upon removal of the cast the old symptoms recurred, and with them the adduction relapsed.

She was brought by her family to me for two purposes: for the relief of symptoms at the hip, and for correction of the adduction and practical shortening.

X-rays showed a marked degree of destruction in the hip-joint, and my examination confirmed the presence of active tuberculosis.

An operation precisely similar to that described under Group Ia was performed (Fig. 8), and the result has been most satisfactory, the symptoms and the adduction having been completely controlled.

The hip is indeed the most favorable monarticular joint in the whole body for function following arthrodesis, because of the very efficient compensatory motion at the lumbar spine and knee.

CASE III.—J. H., a man of forty-five, complained of lameness, pain, stiffness and limited motion at the hip, and weakness following use. These symptoms had persisted for six years, during which he had been treated elsewhere by medication and by osteopathic manipulations.



FIG. 15.—Same case as Fig. 13.

Extraarticular arthrodesis (Ia) was performed by the author July 11, 1917, and the result was very satisfactory. (Fig. 9.) All symptoms have disappeared.

CASE IV.—A. W., a girl sixteen years of age, had had symptoms in her hip for three years. Motion was exceedingly limited. X-rays showed considerable destruction of the acetabulum, and the head and a portion of the right femur were completely destroyed. She had worn a cast for two and one-half years and walked with crutches.

At operation, December 10, 1923, marked destruction of the hip was found. Operation of the type described in Group Ia was carried out. The result has been most satisfactory. The X-rays (Fig. 10) show proliferation of the grafts. The patient can walk two miles without fatigue, and with no support of any kind. She also swims.

This case demonstrates to a very unusual degree the general characteristics of the pathology of tuberculous bone and joint disease, namely, the pronounced amount of bone destruction with practically no coincident bone repair or bone proliferation (Fig. 10). This is peculiar to the tubercle bacillus in that in the case of every other chronic infection there is a corresponding amount of bone repair and bone proliferation going on coincidentally with the bone destruction.

CASE V.—M. M., a housewife thirty years of age, had been unable to walk without support for five years on account of pain in the left hip. She was at first told that she was suffering from rheumatism and was treated for this. She was then put to bed and a spica applied, which was left on for one year. Sunlight treatment was also given. When seen by us the patient had been in bed fifty months.

Examination showed one inch actual shortening of the left leg. There was marked pain in the hip upon any movement, especially on rotation of the head of the femur. Considerable muscle spasm was also noted around the joint.

X-rays revealed marked erosion of the left acetabulum with marked bony destruction. The head of the left femur was very much eroded, and areas of bone destruction were noted over the entire head of the femur. The neck of the femur was approximately one-half that of normal size, and there was marked bone atrophy of the whole upper half of the left femur. She had a temperature of 100.3° and had been running a temperature around 100° for the past two years.



FIG 16—Same case as FIG. 13.

A diagnosis of tuberculosis of the left hip-joint was made, and operation undertaken January 10, 1927. A large tuberculous abscess about the size of a large lemon was attached to the anterior-inferior surface of the joint capsule. This was not incised or drained. The technic described under Group 2a was carried out, the greater trochanter being split longitudinally downward with a broad osteotome for about one and one-half inches, and a graft slid down from the outer table of the ilium into the groove previously made in the trochanter. The muscles and skin were then closed in the usual way, dressings applied and a spica cast put on, extending from two inches above the umbilicus to the toes. The operation took one hour.

In this case 500 cubic centimetres of normal saline solution was given subcutaneously immediately following operation, and 500 cubic centimetres intravenously six hours later, as the patient's resistance had been greatly lowered by the long-standing infection and so many years in bed. She reacted well. The cast was removed in three months, and the wound had healed perfectly. X-rays taken at this time showed the graft in place. The patient had gained fifteen pounds and had had no pain or discomfort. Another cast was applied, and left on until June 1, after which the patient wore a Phelps brace.

The patient was last seen in February, 1928, when she was in excellent condition, walking without brace, cane, or crutch.

CASE VI.—R. D., a young woman of twenty-eight, has a very interesting history.

She had had trouble with her hip since she was five years old. For two years she was in bed with casts and braces. She then went without treatment for seventeen years, and got about with limited motion. In April, 1916, pain began again and prevented walking. She was given X-ray treatments in Arizona and, when these failed, was sent to a prominent orthopædic surgeon of Los Angeles, who put her in a plaster cast for four months. In January, 1917, he decided to operate and performed an intraarticular arthrodesis. Following this operation the patient received heliotherapy, and was able to get about with a cane; but active symptoms persisted, ankylosis not having been secured. Such failure following intraarticular arthrodesis would occur in a large percentage of cases, because of the inhibition of osteogenesis by tubercle bacilli and the recession of bony surfaces.

In March, 1918, she came to the author, with increasing adduction deformity. X-rays showed marked destruction of the acetabulum, with complete destruction of the head and most of the neck of the femur.

An extraarticular arthrodesis was performed at Postgraduate Hospital, a bone graft being taken from the crest of the ilium (2a.) (Fig. 2.) Following the operation the leg was immobilized in moderate abduction by means of a long plaster spica. The pathological report was tuberculous osteomyelitis and periostitis.

CASE VII.—G. B. This patient first consulted me in 1923, when she was eleven years old. She had then had trouble with her hip for five years, with much pain, limited motion, and a tendency to adduction and inward rotation. During these five years she had been under conservative treatment, wearing a Phelps brace day and night. Weights on the bed had also been applied, but the symptoms did not subside. X-rays showed considerable destruction of the acetabulum and head of the femur.

November 8, 1923, I performed an extraarticular arthrodesis of the hip, with two massive bone grafts from the tibia, the adduction deformity not being corrected for fear of reactivating the disease. The cast remained on for ten weeks, after which massage was instituted. In February the patient went home on crutches. In May she began walking without cane or crutch.

In 1925 all symptoms had subsided, but there were two inches of practical shortening, and three-fourths of an inch of actual shortening. In September, 1926, the practical shortening was overcome by means of a circular Gant's osteotomy. Following this operation the leg was put up in moderate abduction for eight weeks. Then massage was given for one month. Her parents then requested that while she was still in the hospital an operation be done to correct the marked knock-knee which was a result of the early, long-continued brace treatment of her hip, and which she had had ever since the adduction deformity developed.

A supracondylar osteotomy was therefore done, and the deformity held in overcorrection by means of a hip spica including the foot. This was left on for eight weeks. The correction and result were excellent.

In the summer of 1927 she went to camp, the extremity functioning very well. In September she returned to me again for a check-up examination. The knock-knee was entirely corrected, and her physical condition was so good that her mother suggested the possibility of an operation for motion at the hip, particularly as the patient was beginning to object to the awkward position which she was obliged to assume in sitting. The family were impressed with the risk of operating upon an old tubercular hip.

An arthroplasty of the hip was done September 19, 1927. Following the operation the hip was in a cast for three weeks with traction. After its removal massage was started, but traction continued. The patient was discharged from the hospital November 20, traction and massage being continued at home.

December 1 a limited amount of weight-bearing was permitted, and this was gradually increased. January 10 she discarded the crutches and used a cane. Late in January traction was discontinued.

The patient returned to school February 1 and on Washington's birthday went to Atlantic City, where she swam 120 feet in a pool.

March 15, six months after the arthroplasty, she had ninety degrees of normal painless motion in all directions. She is walking nearly a mile a day without a cane. All symptoms have subsided and she has only a slight limp. This case is a striking example of the possibilities of reconstruction surgery, and further emphasizes the importance of selecting a technic that is completely extraarticular and causes a minimum of damage to the musculature about the hip. In other words, one should formulate the arthrodesis procedure in such a way as to afford the most favorable conditions for a future arthroplasty for mobility. The technic used in this case, with tibial grafts, has distinct advantages in this respect. (Fig. 12.)

CASE VIII.—B. F., a girl of seventeen years, had fallen while running on a stone floor, ten years before our examination. During this ten years she had been treated by the best orthopædic surgeons in England by various conservative measures, including traction, plaster casts, Thomas splint, and heliotherapy, with absolute failure to relieve symptoms, or to overcome the adduction deformity.

X-rays showed old tuberculosis of the hip, with moderate destruction.

March 5, 1925, at Postgraduate Hospital, an operation of the type described as Group 1b, with a graft from the trochanter, was done. The result was very satisfactory.

This case is particularly interesting in view of the continued failure of conservative measures.

## MORTISED GRAFTS VERSUS CHIP GRAFTS—THEIR RELATIVE MERITS

As a result of extensive animal experimentation and experience in the use of the bone graft during the last eighteen years in arthrodesis of the hip and other joints by both extra- and intraarticular methods, I have been convinced of the necessity of using strong grafts well mortised into both bone elements on each side of the joint. Numerous irregular shaped grafts packed around the periphery of the joint are not trustworthy in view of the fact of Nature's tendency to restore mobility in a joint. In many instances in cases operated on by others and some operated on by myself by the chip-graft method, I have had to reoperate in the spine, hip, and other joints after the failure of the so-called "fusion" operation where only unmortised chips of bone were used, even though complete intraarticular removal of cartilage from both head of femur and acetabulum had been done in favorable osteoarthritic cases.

In evaluating osteogenetic possibilities at the operating table one should, for the sake of safety, consider them to be the lowest rather than the highest; for there is, unfortunately, no way of measuring pre-operatively in a given case the osteogenetic factor, which varies widely with individuals. To allow the largest possible margin of safety, it is therefore wise to plan every bone operation as if it were the case with the lowest potentiality of callus formation.

If one assumes that the patient has a moderate or high degree of osteogenetic potentiality and plans his operative procedure on this assumption, he may be doomed to disappointment, finding post-operatively that in this particular case the osteogenetic factor was extremely low, and too much had been left to Nature. If the graft had been accurately mortised even a low

degree of osteogenesis would have been sufficient to produce ankylosis, and the desired result would have been attained.

In May, 1907, at Postgraduate Hospital I supplemented an intraarticular arthrodesis for osteoarthritis in a male adult by placing extraarticularly, around the periphery of the joint, chip grafts.† Subsequently the author used this chip-graft method in a large number of cases of osteoarthritis, a condition that is far more favorable to the securing of ankylosis by surgical operation than bone tuberculosis because the inhibitory influence of the tubercle bacillus on osteogenesis is not present. But even under these most favorable conditions, there were occasional delayed unions or arthrodeses and failures to secure arthrodesis in cases in which chip grafts were used, so that for the past ten years I have employed the mortised graft instead of the chip grafts exclusively for all types of operation, using chip grafts only to supplement the inlay, peg, or mortised graft.

In view of the unfavorable results too often obtained when chip grafts are used to supplement extraarticular and intraarticular arthrodesis, the untrustworthiness of primary extraarticular arthrodesis by means of such grafts, as in cases of tuberculosis, is apparent and the advantages of massive, carefully mortised grafts are easily appreciated.

These advantages may be briefly stated as follows:

1. The massive mortised grafts have a marked influence toward producing immobilization from their internal splint action. 2. They serve as a continuous vascular conducting scaffold from one side of the joint to the other, the first and most important requisite for bridging callus formation. 3. They bring about a very close apposition of the graft tissues to the host tissues, thus furnishing the most favorable conditions for the establishment of blood circulation from host tissue to graft tissues.

The importance of this has been recently emphasized in a most striking way by research work done by Bohlman and Johnson at Johns Hopkins University, which shows that osteogenesis has an immediate and definite relationship to blood supply, the establishment of which must precede osteogenesis.‡

In other words this whole consideration is a biological one, and much can be learned in an operative way from the study of grafts when applied in the vegetable kingdom. The scientific foundation for the inlay mortised grafts as compared with the haphazard chip grafts is obvious.

In cases in which a second operation became necessary following intraarticular arthrodesis with extraarticular chip grafts done by myself and by others, and in spinal cases where chip grafts had been used elsewhere to "fuse" the spine, the author has been able to check up at reoperation as to

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† Albee: Jour. Am. Med. Assn., June, 1908.

‡ Johnson, Robert W.: A physiological study of the blood supply of the diaphysis. Jour. Bone and Joint Surg., 1927, vol. ix, p. 153; Bohlman, personal communication.

the condition of these chip grafts, and has been impressed by the fact that no one can foretell individual osteogenetic potentialities.

In many instances of both hip and spine I have found the chip grafts lying in place without any two of several dozens having united. In one such case of spondylolisthesis on which the author operated recently in which a chip-graft fusion had been attempted a year and a half before by a prominent advocate of the fusion operation, I was unable to find union of any two of the chip grafts when I laid bare the field. Undoubtedly this was a case of low osteogenesis. X-rays taken May 1, 1928, five months after my operation, show the massive mortised graft to be firmly united, in spite of the low osteogenetic factor. Further complete relief of all symptoms has resulted from the massive inlay graft operation. It might be mentioned in passing that in many instances it is impossible to determine by X-ray whether or not fusion has resulted from the insertion of chip grafts.

I wish to combat the statements repeatedly creeping into the literature that accurate mortising work by electric bone mill technic can only be accomplished "at the cost of considerable time". The time-consuming factor is not the mortising, but the hesitancy and lack of experience of an operator who has not taken the pains to perfect himself in motor technic. Many an otherwise able surgeon is unfortunately a novice, or still in the stage of internship, when it comes to the use of electrical instruments, and his lack of skill with the rapidly moving tools causes a hesitancy which is indeed time-consuming. Once the surgeon has made himself as familiar with these machine tools as he is with his knife and osteotome, it certainly does not take more time to cut an accurately shaped bone with automatic machine tools than to chip it with hand instruments. Extraarticular arthrodesis of the hip as performed by the author is completed in from thirty to forty minutes.

To the frequently recurring argument regarding the relative merits of chip grafts and mortised grafts, advocated with equal enthusiasm by opposing schools, there is but one answer, the biologic considerations and the end results in the hands of those surgeons who have equipped their operating rooms and trained themselves in both types of technic so that the end results are really comparable. The author has had much experience with both types, and for the reasons already set forth in this paper, finds the evidence —experimental, biologic, and clinical—strongly in favor of the carefully mortised graft.

That the general surgeon who only occasionally is called upon to do bone-grafting work, and is rarely equipped for or experienced in doing mortised inlay work, may well be tempted to use the chip-graft method I can readily understand. But the orthopædic or bone surgeon should not ignore the speed, precision and delicacy of technic which the mastery of electrically driven automatic bone-cutting machine tools alone affords.

31 Cases of Extraarticular Arthrodesis of the Hip with End Results.

TABLE I.

| Case | Age | Duration of symptoms | Symptoms | Previous treatment | Our treatment | Result |
|---|---|---|---|---|---|---|
| 1. B. F. | 17 | 10 yrs. | Fixed flexion adduction deformity. | Traction; plaster splint; heliotherapy. | Extraarticular arthrodesis, 3/5/25. | Very satisfactory. |
| 2. H. F. | 18 | 9 yrs. | Pain and weakness in hip; adduction deformity. | Splint; high shoe; prolonged rest in bed; stretching under anaesthetic to overcome adduction. (Relapsed.) | Extraarticular arthrodesis, 9/11/20. | Pain relieved. Function of leg very satisfactory. |
| 3. A. W. | 16 | 3 yrs. | Limited motion; marked destruction of hip. | Cast for two and one-half yrs. | Extraarticular arthrodesis, 12/10/23. | Good function, walks 2 miles. Swimming; |
| 4. L. G. | 31 | 26 yrs. | Pain. | Operated on when six yrs. old; type of operation not known. Plaster cast. Brace. | Extraarticular arthrodesis recommended. | Good. |
| 5. H. N. | 12 | Not stated. | Pain. | Brace (had had bone graft for Pott's disease). | Extraarticular arthrodesis recommended. | Refused operation. |
| 6. R. R. | 12 | 8 mos. | Limited motion; shortening. | Traction; brace; cast. | Extraarticular arthrodesis, 4/7/22. | Good. |
| 7. J. S. | 13 | 10 yrs. | Limited motion. | Rest in bed; extension; cast. | Extraarticular arthrodesis, 3/24/27. | Good. |
| 8. N. L. | 43 | 5 yrs. | Pain; night cries; limited motion. | Brace for two yrs. | Extraarticular arthrodesis, 11/4/22. | Good. |
| 9. J. L. | 13 | 6 yrs. | Pain and inability to walk. | Extension two yrs.; plaster cast. | Extraarticular arthrodesis, 10/30/17. | Excellent. |
| 10. J. H. | 45 | 6 yrs. | Pain; night cries. | Medical, and osteopathy. | Extraarticular arthrodesis, 6/1/18. | Excellent. |
| 11. A. G. | ? | 13 yrs. | Lameness; pain; stiffness; limited motion; weakness following use. | Extension with weight; brace | Extraarticular arthrodesis, 7/11/17. | Excellent. Gained 30 lb. after |
| 12. W. R. | 27 | 9 yrs. | Pain; limp; walks with cane. | Operation for bow legs. | Extraarticular arthrodesis recommended. | Good. |
| 13. E. E. | ? child | 4 yrs. | Pain; weakness; stiffness; almost complete destruction of femoral head. | None. | Extraarticular arthrodesis, 2/24/18. | Refused operation. |
| 14. C. M. | 14 | 4 yrs. | Pain; limp; walks with crutches. | Gant's osteotomy. | Extraarticular arthrodesis recommended. 12, 20/13. | Good. Patient is foreman of brush factory, 1926. |

*Extraarticular Arthrodesis of the Hip—Continued.*

| Case | Age | Duration of symptoms | Symptoms | Previous treatment | Our treatment | Result |
|---|---|---|---|---|---|---|
| 15 B. S. | 45 | 25 yrs. intermittent, 5 yrs. constant. | Walking difficult and painful. | Cast for six months before our examination. | Extraarticular arthrodesis, 12/7/16. | Good. |
| 16 J. M | 50 | 7 yrs. | Walks with crutches. | Cast for two and one-half yrs. | Extraarticular arthrodesis, 1/26/18. | Excellent. |
| 17. J M. | 4 | 2 yrs. | Pain and shortening, abscess. | Cast for nine months. | Extraarticular arthrodesis, 12/2/19. | Good. |
| 18. G. B. | 11 | 5 yrs. | Pain and limp, adduction deformity. | Phelps brace, limited motion, adduction and inward rotation. | Extraarticular arthrodesis; subsequent arthroplasty. 9/23/26. | Excellent; swim 300 yds. |
| 19. J. W. | 22 | 6 yrs | Pain, unable to bear weight | Cast at two-month intervals for past year. | Extraarticular arthrodesis, 1/17/21. | Good. |
| 20. F. Z. | 19 | 4 yrs. | Pain. | Stretching; manipulation; cast seven months; brace. | Extraarticular arthrodesis, 10/9/24. | Excellent. |
| 21. M. W. | 18 | 12 yrs. | Deformity, limited flexion. | Plaster cast; brace for five yrs., high shoe. | Extraarticular arthrodesis, 3/27/22. | Good. |
| 22. E. A | 27 | 5 yrs. | Limp; pain without brace. | Plaster cast; violet ray; brace. | Extraarticular arthrodesis recommended. | Refused operation. |
| 23. C. H. | 58 | 15 yrs. | Limp; stiffness, dull pain. | Massage; osteopathic treatment; baking. | Extraarticular arthrodesis recommended. | Refused operation. |
| 24 R. P. | 24 | Since infancy | Limp; shortening; slight rotation and flexion adduction. | Osteotomy. | Extraarticular arthrodesis recommended. | Refused operation. |
| 25. H. L | 22 | 19 yrs. | Marked limp; slight pain; limited motion. | Bradford frame; casts seventeen wks; braces eleven wks. | Extraarticular arthrodesis recommended. | Refused operation. |
| 26. C. K. | 16 | 10 yrs. | Pain and limp; easy fatigue. | Casts for five yrs.; none for last five. | Extraarticular arthrodesis, 3/10/24. | Good. |
| 27. E. H. | 24 | 3½ yrs. | Pain, stiffness, all motion limited; outward rotation. | Cast for five months. | Extraarticular arthrodesis recommended. | Refused operation. |
| 28. G. D. | 59 | 5 yrs. | Pain; shortening, difficulty in walking. | Treated for rheumatism. | Extraarticular arthrodesis, 1/12/22. | Good. |
| 29. J. C. | 29 | 20 yrs. | Pain on weight bearing and walking. | Cast, stretching, manipulation, diagnosed as tumor. | Extraarticular arthrodesis recommended. | Refused operation. |
| 30. A. B. | 23 | 14 yrs | Pain, shortening, limp, limited motion; flexion deformity. | None. | Extraarticular arthrodesis recommended. | Oblique osteotomy done. Good result. |

| | | | Pain; rotation in flexion. | Strapping. | Extraarticular arthrodesis, 8/28/24. | Very good. |
|---|---|---|---|---|---|---|
| 31. A. C. | 18 | 1 yr. | | | | |
| 32. M. C. | 29 | 20 yrs. | Walks with crutches; shortening. | X-ray treatment; quartz light; brace for six mos. Has persistently refused operation. | Extraarticular arthrodesis, 4/28/22. | Local doctor reports "remarkably good result" in 1926. |
| 33. H. G. | 35 | 4 yrs. | Pain; marked spasm. | None; graft for Pott's disease. | Extraarticular arthrodesis, 3/5/25. | Excellent. |
| 34. D. H. | 4 | 5 mos. | Spasm of muscles; pain; easy fatigue; night cries. | Cast. | Extraarticular arthrodesis, 1/24/27. | Good. |
| 35. F. L. | ? | Not stated. | Not stated. | History incomplete. | Extraarticular arthrodesis, 3/15/18. | Good. |
| 36. H. B. | 16 | 8 yrs. | Limp; no pain; marked adduction deformity; uses crutches. | Plaster spica for nine mos.; abscess ruptured under cast; no discharge last five years. | Osteotomy, 10/22; extraarticular arthrodesis, 10/23. | Fair. |
| 37. M. M. | 30 | 5 yrs. | Pain; inability to walk; shortening; muscle spasm. | Plaster spica one yr.; rest in bed four yrs.; sunlight. | Extraarticular arthrodesis, 1/9/27. | Good. |
| 38. R. D. | 26 | 21 yrs. | Pain; walks on crutches. | In bed two yrs.; casts; braces; after interval of several years, casts reapplied; then intraarticular arthrodesis; helio-therapy. | Extraarticular arthrodesis, 3/25/18. | Very good. |
| 39. S. A. | 31 | 9 yrs. | Pain. | Electricity and liniment for rheumatism; weight; cast for three yrs.; abscess opened. | Extraarticular arthrodesis. | Good. |
| 40. A. V. N. | 30 | 5 yrs. | Pain; spasm; limp; shortening; unable to bear weight. | Treated for rheumatism and sciatica for four yrs.; no X-ray for five yrs.; in bed two months. | Extraarticular arthrodesis, 5/27. | All pain gone. Very slight limp; has gained sixteen pounds since operation. |
| 41. L. G. | 3½ | 7 mos. | Pain; night cries; marked muscle spasm; unable to walk. | Traction; Phelps brace; plaster cast six mos. | Extraarticular arthrodesis, 5/10/26. | Excellent. |

In every case except Case 40, pre-operative X-rays revealed destruction of the acetabulum and of the head of the femur. In many instances the destruction was of marked degree. In Case 40 diagnosis uncertain.

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# ASTRAGALO-SCAPHOID DISLOCATION

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It may be considered not unworthy of note that relatively few cases of simple, uncomplicated dislocation at the astragalo-scaphoid joint have heretofore been recorded. The paucity of such observations is the more striking when it is realized that numerous authors both in this country and abroad have dedicated rather, imposing monographs to the study of the different types of injuries which the astragalus has suffered. In the category of these injuries fracture of the astragalus and its dislocation at the ankle joint have undoubtedly held the premier rank, while other conditions seem to be far in the minority. Thus there appear to have been observed somewhat less than twenty instances of dislocation at the mid-tarsal (Chopart's) joint, while only about 139 cases of dislocation at the subtarsal joint have been reported. If the firm ligamentous attachments of the astragalus with the calcaneus be contrasted with the comparatively relaxed astragalo-scaphoid ligaments, it will seem still the more strange that so insignificant a number of luxations should have taken place in the joint through which a great part of the mobility of the tarsus is mediated.

For a long time it was seriously questioned whether simple dislocations in this joint were at all possible, though now incontrovertible examples have apparently disposed of this doubt. However, if the opinion of Gümbel who has made a careful study of the subject be accepted, there were up to the year 1911 only nine well-authenticated cases of dislocation at the astragalo-scaphoid articulation. Of these, two were subluxations: Boeckel,[3] Gümbel,[8] and seven were true complete dislocations: Chassaignac,[5] Dubrueil,[4] Wodarz,[16] Morian,[10] Rais,[11] Boeckel and Gümbel. The cases of Roux, Boyer, Richerand and Beever admitted by Boeckel to the group of talonavicular dislocations were criticized and rejected by Gümbel as being improperly described and classified. The cases reported in the *Lancet*,[1, 2] that of Wells[13] and the two cases reported by Garr,[6] seem most certainly to suggest true astragalo-scaphoid dislocations, but their descriptions appear to be insufficiently complete to warrant their inclusion. Since 1911 several new cases have been reported to which the dignity of entry into this very exclusive circle may justifiably be granted: Goebel,[7] von Winiwarter[14] two cases, Juhel[9] and Winter.[15] There is then a list of some four or five suspicious cases and another well-established list comprising two cases of subluxation and twelve of complete luxation at the astragalo-scaphoid articulation. The following case[17] is therefore to the best of my knowledge the thirteenth complete luxation thus far in the literature. But regardless of its position in the numerical category, the case here presented is the more interesting in that

it is, I believe, the first in which careful stereoröntgenograms have permitted of accurate study and description of the relationships of all the tarsal joints.

I. B., male, aged thirty-five, was admitted to the hospital March 19, 1928, following an injury to the left foot. He recounted that while working on a ladder he had lost his balance, fallen a distance of about five feet and landed with his whole weight (175 pounds) on his left foot. Though he could not remember the exact attitude of his foot at the moment of impact, he believed that the foot turned under him into supination. The patient complained of a great deal of pain directly after the injury, but under conservative treatment this had gradually diminished so that at the time of examination he was able to bear weight and even hobble a few steps without any pain. Before his admission the patient had been X-rayed by Dr. M. Pomeranz, röntgenologist to the hospital, who very clearly diagnosed the exact nature of the injury. In order to more positively exclude the possibility of other associated lesions, I requested the taking of stereoscopic plates, which were reported: "Stereoscopic examination of the left foot in the dorso-plantar position shows the following: There is no evidence of fracture of the tarsal bones. The forefoot is moderately inverted and adducted. The inner border is



FIG. 1.—Dorso-plantar röntgenogram (Stereo) showing dislocation of the astragalus, before reduction.

apparently raised. The bone structure of the cuneiforms, the scaphoid and the cuboid is somewhat obscured by the presence of an effusion. The scaphoid bears its normal relation to the internal cuneiform and the cuboid. The cuboid is in normal relationship with the os calcis and the bases of the outer metatarsal bones. The head of the astragalus, apparently dislocated from its articulation with the scaphoid, points upward and outward and rides over the cuboid and to a slight extent over the cubo-scaphoid junction. The astragalus is apparently rotated slightly outward about its vertical axis, but appears to be in normal relationship to the articular surface of the os calcis.

"Stereoscopic examination of the left foot in the lateral position shows but slight changes from that seen in the dorso-plantar position. The calcaneo-cuboid articulation appears to be normal, as does the astragalo-calcaneal and the scapho-cuneiform. The astragalus appears to be in its normal relationship with the tibi, fibula and the os calcis, but appears to be rotated slightly outward in the horizontal plane.

"From these stereograms, it would appear that the tibio-tarsal, the astragalo-calcaneal, the calcaneo-cuboid, the cubo-scaphoid and the scapho-cuneiform joints are in their normal positions. *The dislocation appears to have taken place solely in the astragalo-scaphoid joint.*" (Fig. 1.)

When seen at the hospital the patient presented what are believed to be signs typical of an astragalo-scaphoid dislocation. The foot was held in marked varus and was so swollen that of the bony landmarks only the external malleolus was visible. The color,

the vascular pulsations, the sensory and the motor power of the foot were apparently good. The foot, however, was in a fixed varus. Extension and to a lesser degree plantar flexion, and inversion, could be carried out. Eversion was impossible. The head of the astragalus could be palpated beneath the skin pointing upward and outward. Pressure over the head was painful. Between the scaphoid and the internal malleolus, in the region normally occupied by the head of the astragalus, a deep depression could be felt. The forefoot was adducted and obviously shortened. From the tip of the right internal malleolus to the great toe, the distance measured eight and one-fourth inches, while in the injured foot, the measurement was only seven and one-half inches.

On March 22, 1928, under general anæsthesia an attempt was made to reduce this dislocation. While the ankle and foot were firmly held by an assistant, the forefoot was strongly plantar-flexed and adducted. Traction was made at right angles to the tibia in the line of the axis of the astragalus and counterpressure was applied against the head of the astragalus, without success. Several efforts having failed, it was decided to apply the reducing force in the direction which was presumed to be that of the force which had



Fig. 2.—Dorso plantar röntgenogram showing relationship of astragalus after reduction. By actual measurement upon these two röntgenograms the shortening of the internal border of the foot can be seen to be due to the displacement of the head of the astragalus.

produced the injury. Consequently, the foot was plantar-flexed, adducted and inverted, *i.e.*, sharply supinated and plantar-flexed. Thanks to the integrity of the ligaments of the forefoot, the scaphoid followed the direction of the forefoot and slipped from beneath the neck of the astragalus. With a snap that could be heard several feet away, the head of the astragalus slipped into place. Immediately afterward, both active and passive motions appeared to be relatively free and painless in all directions. The depression previously felt behind the scaphoid was now found to be occupied by the replaced head of the astragalus. The distance from the internal malleolus to the tip of the great toe measured eight and one-fourth inches as in the right foot, and X-ray photographs showed that the luxation had been reduced. (Fig. 2.) A plaster-of-Paris bandage case, with the foot in moderate valgus and at right angles to the leg, was applied from the toes to midway up the leg.

At the end of two weeks, preparatory to the beginning of physiotherapy, another X-ray was taken and to my chagrin I discovered that the dislocation had recurred within the case. The patient was therefore again taken to the operating room, and the dislocation again reduced. The foot was this time put up in an extreme flat-foot position with a thick pad making pressure over the head of the astragalus. Repeated röntgenograms showed the maintenance of the reduction, but evidence of a mild arthritis, probably traumatic, at the astragalo-scaphoid joint. At the end of three weeks the case was bivalved and baking and massage begun. Both active and passive motion in all directions

was free and painless. The patient was advised to begin weight-bearing in the case. At the end of a week of such treatment the case was entirely removed and a shoe with an external elevation of one-fourth inch was prescribed. Within three weeks the patient was able to use his foot freely and without discomfort and he was consequently discharged as cured.

Either as a result of inaccuracies or omissions in description of the other tarsal joints, a great deal of misconception and confusion appears to have crept into our current ideas concerning talo-navicular dislocations. Thus the term "subtalus dislocation" has been used to include dislocations occurring at the astragalo-navicular, at the astragalo-calcaneal or in the mid-tarsal joint. "Medio-tarsal dislocation" has been taken to connote true medio-tarsal as well as talo-navicular dislocations, while "astragalo-scaphoid dislocation" has been made to embrace not only dislocations at this joint but also dislocations of the scaphoid alone. To these errors some of our most eminent authors have fallen victim.

Properly speaking, the term "subastragaloid" should be reserved for those cases in which the astragalo-calcaneal as well as one or both of the medio-tarsal ligaments have been torn but in which the tibio-tarsal ligaments have remained intact. In typical instances these cases are characterized by definite röntgenological and clinical manifestations as, for example, the apparent lengthening of the heel. "Medio-tarsal" should be applied only to those cases in which it can be demonstrated that both the calcaneo-cuboid and the astragalo-scaphoid joints have been luxated, while the astragalo-calcaneal and all the other tarsal and metatarsal joints bear their normal relationships to each other. As regards isolated calcaneo-cuboid and astragalo-scaphoid dislocations, both of which have been described as occurring alone, it would seem better terminology to consider each as a separate type rather than as partial medio-tarsal dislocations.

With this idea in mind, Dubrueil suggested for talo-navicular luxations the designation of "preastragaloid". This he further modified by the addition of the words *superior* or *inferior,* to indicate the position of the dislocated anterior part of the foot in relation to the head of the astragalus. Although this term has no especial advantage over the more commonly employed "astragalo-scaphoid," it is at least in consonance with modern usage which considers the distal bone as that which is dislocated upon the proximal. It serves, moreover, to emphasize the difference between this and the more usual type of subastragaloid dislocations.

The only apparent disadvantage in the use of this term is that it seems unduly to stress the significance of the pretalus and thus to postulate a mechanism in the production of this injury. This objection is of greater validity in view of the fact that it is precisely the question of mechanism which is most open to dispute in the discussion of these cases. Chassaignac in his brief treatment of the subject described the tearing of the dorsal astragalo-scaphoid ligaments as a result of supination of the forefoot, and the subsequent dislodgement of the head from its articulation with the

scaphoid as one would squeeze a melon pip between the fingers. Reissman[12] too, in a much more detailed article on subtalus dislocations, thought the head was dislocated in consequence of excessive supination of the forefoot. Morian, on the other hand, maintained that the explanation was to be sought in the concurrence of a supinating and an extending force. However, employing this mechanism experimentally, he was able to reproduce this luxation but once and then only in a young child. Gümbel, more inclined to the acceptance of Morian's than Reissman's theory, felt the necessity of amending it by the addition of a dorsi-flexing force acting only upon the inner half of the foot.

While all of these theories doubtless represent a large part, if not all of the facts, the reader is left with a singular feeling of their incompleteness when the general principle is applied to the explanation of the individual case. The actual displacement of the head of the astragalus seems to be adequately accounted for, yet the fact that the head is at one time found pointing to the dorsum and at other times to the plantar surface of the foot is passed over in a somewhat vague manner. All those who have written on this subject have affirmed the importance of supination or pronation in the mechanism of this injury but none have insisted upon the rôle played by wedge-like action of the head of the astragalus itself. It seems that if, instead of considering the forefoot as the prime factor, the emphasis were placed on the astragalus as the active force, the mechanism here suggested would present a simpler and more consistent explanation of the different forms of talo-navicular dislocation. This can, perhaps, be best appreciated from a review of certain already established facts of the anatomy and physiology of the astragalus.

If a normal foot be examined in the fresh state it will be seen that the astragalus is the only bone in the body which has no muscles attached to it, despite the fact that about it centre the most important motions of the tarsus. In its motion, consequently, it is subject to the forces transmitted to it through its perfectly adapted tibial, calcaneal and scaphoid articulations. In this respect it may almost be considered to function as a sort of meniscus interposed between the leg and the rest of the tarsus. When the foot is flexed or extended, the astragalus acts as a firmly-fixed part of the tarsus, while when the forefoot is supinated or pronated it remains motionless and may be thought of as an integral part of the leg. Apart from this function in mediating the motions of the foot, the astragalus functions to distribute the body weight to the calcaneus and the heads of the first and fifth metatarsal bones, the three points of support of the tarsal tripod.

In the anatomical position, the ligaments forming the astragalo-scaphoid capsule are lax and the head, fairly well covered by the scaphoid, points forward and slightly downward in the plane formed by the tibia and the head of the second metatarsal bone. The body weight is transmitted downward to the upper surface of the astragalus and thence is distributed almost equally to the calcaneus, and the heads of the first and fifth metatarsal bones. When the forefoot is put into supination, the head of the astragalus disengages

from its scaphoid covering and about one-fourth of its surface can be felt projecting against the upper and outer part of the capsule. The neck and head of the astragalus now lie in a plane determined by the tibia and the head of the fifth metatarsal bone. The body weight is resolved into three forces of which the component lying in the plane of action is the greatest, while those distributed to the calcaneus and the head of the first metatarsal are the least. When the foot is pronated, the opposite is true. The inner ligamentous structures are put under tension, since the neck of the astragalus and the tibia establish a plane of action which contains the greatest component of the resolved body weight and which passes far to the inner side of the head of the first metatarsal bone. If in each of these attitudes the foot be placed either in extension or inflexion, it can be seen that the forefoot may be brought into four different positions as regards the head of the astragalus. Depending upon the relative strengths of the four active forces, supinating, pronating, flexing or extending, the forefoot tends to look either downward and outward, downward and inward, upward and outward, or upward and inward. At the extremes of these motions, the diagonally-opposite ligaments are put under tension both by the action of the forefoot and by the impingement of the head of the astragalus.

It is, in my opinion, just at this point that the explanation of talonavicular dislocations is to be sought, for it is just at this point that the upward resistance of the ground, transmitted through tension of the capsular ligaments, opposes the downward force of the body weight transmitted through the head of the astragalus. In the case here reported, for example, the following sequence of events may be predicated. As the body of the patient struck the ground on his supinated and plantar-flexed foot, the fall was checked by the resistance of the ground against the foot. Under the influence of this counter-resistance, the forefoot turned more and more into supination and plantar-flexion until the limit set by the length of the astragalo-scaphoid ligaments and the interposition of the soft parts was reached. At this moment the head of the astragalus; continuing to act downward in the axis of fall, was driven like a battering ram against the tense upper and outer parts of the capsule. Being already about half-disengaged, the head of the astragalus slid completely beyond its articulation with the scaphoid and, tearing through the capsular ligaments, came to lie upon the upper surface of the cuboid.

Had the forefoot been in dorsiflexion at the moment of impact, the direction of the force would have been against the outer and lower part of the capsule, and the head would in all likelihood have been displaced outward and downward, and the cuboid would have been found resting on the upper surface of the neck of the astragalus, as in the cases reported by Wodarz, Dubrueil and Chassaignac. On the other hand, if the foot had been in pronation instead of in supination, the dislocation of the head would have been inward and upward, as in the case reported by Winter. The majority of cases reported have been those in which the forefoot was injured in the attitude of

supination and plantar-flexion, and the head of the astragalus consequently pointed upward and outward. Next in frequency were those in which the head pointed downward and outward, while the most unusual were those in which the foot was in pronation at the time of injury. This was to be expected from the knowledge that, when hanging freely under the influence of gravity, the forefoot tends normally to assume a position of supination and plantar-flexion. Though, like the other authors on this subject, I have been unable to verify this hypothetical mechanism by the actual experimental reproduction of this dislocation, it seems, better than the theories previously offered, to account not only for the integrity of the calcaneo-cuboid and astragaloid ligaments, but also for the variations which have been noted in the displacement of the head of the astragalus.

Clinically, astragalo-scaphoid dislocations present certain well-defined characteristics which should at least suggest if not definitely establish the diagnosis. There is usually a history of a severe wrenching of the foot following a fall from a moderate height. The foot is found moderately swollen and held either in a fixed varus or valgus. The head of the astragalus is tender and is usually to be felt beneath the skin in its dislocated position, while at its normal site behind the scaphoid there is a deep depression. The inner border of the foot, measured from the internal malleolus to the tip of the great toe, is shorter than on the unaffected side, while the distance from the inner malleolus to the tip of the calcaneus remains unchanged. By measuring and comparing the röntgenograms of both feet it can be seen that this variation is due solely to the displacement of the head of the astragalus. And finally, the stereoröntgenogram is absolutely diagnostic. Without its aid, the differentiation between talo-navicular and medio-tarsal dislocation would be well-nigh impossible. With it the recognition of tibio-tarsal, subtarsal, medio-tarsal or scaphoid dislocations becomes a relatively simple matter.

The treatment of course consists in reduction at the earliest possible moment. In the early cases this has usually been easily accomplished. Certain hindrances to reduction have, however, been observed. Thus, after several failures at closed reduction, Goebel found, at operation, that the obstruction in his case was the tendon of the tibialis anticus muscle. Others have found that the interposition of the frayed-out capsular ligaments has prevented reduction. In such cases, as well as in those treated after the lapse of some time, recourse must be had to open operation. Simple reduction with suture of the torn ligaments, astragalectomy and even scaphoidectomy have been attempted with varying degrees of success. On the other hand, in instances where reduction was impossible and the patients refused operative intervention, moderately good function of the foot was obtained without treatment (Rais, von Winiwater). In the case here presented the difficulty was found not in the reposition but in the maintenance of the reduction. Following the first effort, when the dislocation recurred within the case, an attempt was made to prevent reluxation by bringing counterpressure to bear against the head of the astragalus. Had this been unsuccessful, it was felt that operation,

28                                    433

either Hoke's subastragaloid arthrodesis or an arthrodesis of the astragalo-scaphoid joint, would have been justified. Fortunately, the satisfactory outcome precluded resort to this rather unpleasant necessity.

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# ASTRAGALECTOMY FOR FRACTURES OF THE ASTRAGALUS

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At best, the operation of astragalectomy is mutilating. The removal of the astragalus, which is the keystone of the bony arch of the foot, the substitution of a new joint for the ankle, the widening of the mortise between the malleoli by removal of some of the articular cartilage from both, as is frequently necessary—these steps must result in what is far from a normal foot.

Yet the operation, wisely used, is of much benefit. Originated by Whitman as a procedure for the aid of paralytic calcaneus and calcaneo-valgus deformities, it fell later into some disrepute because of its application by other less experienced surgeons to virtually all deformities of the foot. The consensus of opinion of orthopædic surgeons today seems to be that astragalectomy is an efficient operation for those deformities for which Whitman devised it, but that for varus and valgus positions of the foot, the sub-astragaloid arthrodesis is preferable.

At various times, more often in the first few years following Whitman's description of astragalectomy than recently, removal of the astragalus has been practiced for fracture of that bone. Most recent writers have mentioned this procedure only to condemn it. Cotton [1] says, "It is hard to find any justification for the astragalectomies still occasionally performed in these cases". Scudder [2] advises the removal of a fragment of the astragalus when it cannot be accurately reduced, but does not advise removal of the entire astragalus, except in compound fractures. Wilson and Cochrane [3] state that operative intervention may be indicated in comminuted fractures of the body of the astragalus, but as a late procedure. They do not mention astragalectomy. A search of the American literature since 1916 on fractures of the astragalus reveals little sympathy for astragalectomy as a method of treatment. Kellogg Speed [4] is an exception, saying, "If the bone is broken horizontally or severely comminuted, or part is driven down into the calcaneum, it should be completely removed by open operation at once".

This condemnation is natural. No surgeon wants to do an amputation; nor does one like to remove from the foot one of its most important bones. Yet we believe that in a certain number of cases of fracture of the astragalus there is no alternative to an astragalectomy. It is better to have the "rocker motion" of the foot on the leg, which follows astragalectomy, than to have the stiff and painful ankle which often precedes it.

We have recently looked over our records to ascertain the number of astragalectomies done for fractured astragalus since 1919. Ten patients have had the operation for this cause. Probably there were a few others

on whom office records were faulty or not kept. But it is likely that this is within two or three of the total number of cases in which we have done this operation for fracture of the astragalus in the past nine years. It was thought to be of interest to review these cases, to consider the indications for removal of the bone, and to learn the ultimate result from the operation.

Fracture of the astragalus, while not common, is not unusual enough to deserve the brief discussion that most text-books devote to the subject. Certainly, when inefficiently treated or when overlooked, as one of our cases was, it is a very disabling injury. There are some simple linear fractures of the astragalus, without displacement, complained of as "sprained ankle" by the sufferer, and evident only by use of the X-ray, which are easy to cure by external fixation and massage. These are often overlooked, and the result is merely static trouble of the foot. But most fractures of the astragalus are due to severe trauma and are not simple. There is often severe comminution and crushing of the body, or the less crippling fracture of the neck with displacement of the head. These injuries, unless expertly treated, leave deformity and disability in their wake, and even when under the care of an excellent surgeon often demand operation.

*Previous Treatment and Time of Astragalectomy.*—Of the ten cases here discussed, only three were seen within a month of the injury. On one of these, seen ten days after injury, closed reduction of the comminuted bone was attempted without success. In another, seen four weeks after injury, another surgeon had unsuccessfully attempted open reduction of a transverse fracture through the body. On the third, seen three weeks after injury, two attempts at closed reduction elsewhere had been unsuccessful, and the foot was in no condition for open operation for nearly four weeks more because of the soft tissue trauma. The other cases were operated on two, four, eight, nine, and ten months, and six and fifteen years, respectively, after the fracture had been sustained. Of these seven cases only four had had any treatment, this consisting of a plaster case applied presumably after attempted reduction. One had not seen a physician for five months after the injury and one had been wrongly diagnosed as a fracture of the external malleolus and treated with an adhesive strapping support for the ankle.

*Type of Fracture.*—Of the ten cases, eight were severe fractures of the body of the astragalus. Six were comminuted, one a compound, comminuted fracture, with a large fragment displaced inward and downward and lying to the inner side of the os calcis, while the eighth was a transverse fracture through the body, with displacement. In one of the remaining cases the fracture line was through the neck; in the other, operated upon fifteen years after injury, there had apparently been a fracture through the posterior margin of the trochlear surface, complicated by a fracture of the internal malleolus. It is interesting to observe that in three patients the condition found at operation was much more serious than the Röntgen-ray appearance led us to expect. In one of these, the röntgenologist reported a vertical fracture through the centre of the trochlea, while at operation, in addition to this,

were found a fracture through the head and another through the body just above the inferior surface. In two other cases the comminution found at operation was much more severe than that seen in the X-ray films. This difference is probably due to the difficulty of obtaining a perfectly clear picture of a bone, part of which is wedged in between two other bones.

*Indications for Operation.*—The indications for operation were pain, deformity, and disability. One case was compound, with the larger portion of the astragalus completely out of the joint, and the indication for removal here was perfectly clear. Six others had suffered for periods ranging from three and one-half months to fifteen years. All of these had pain on weight bearing and two could walk only with crutches. Two showed varus deformity, one eversion and abduction, and another plantar flexion and eversion. One patient was unable to get the heel to the floor without abducting and externally rotating the entire extremity. There is no note as to the deformity of the sixth. All had very marked limitation of motion in the ankle-joint. One patient showed 50 per cent. normal dorsiflexion and plantar flexion, while the others are noted as having very slight, if any, motion in the ankle. The indications in these seven patients for astragalectomy seemed clear. There was practically complete disability of the affected extremity in all, whereas in a non-paralytic case after astragalectomy it is the usual custom of the Industrial Commission in this state to allow 25 per cent. permanent disability of the extremity.

The remaining cases were recent fractures. One, seen three weeks after injury, had such severe crushing of the astragalus that a completely ankylosed ankle seemed certain unless the fragments were excised. Another had severe comminution and displacement. The third showed a transverse fracture of the body in which reduction, though effected by open operation, could not be maintained. It was felt that the disability resultant from non-union or from union in malposition would be greater than that from astragalectomy.

*Operation.*—The operation performed was the astragalectomy of Whitman, which will not be described. After-treatment consisted in a plaster case from above the knee to the toes for six weeks, followed by a short caliper brace which was worn for six to eight months longer. Walking was encouraged as soon after the application of the brace as swelling and pain permitted.

*Results.*—After removal of the astragalus, the foot is necessarily so far from normal that, *ipso facto,* an unusually good result could hardly be called excellent. Those feet in which there are fifteen to twenty degrees motion at the ankle, which are stable, which are painless or only slightly sore after a day's work, and in which there is complete lateral alignment under weight bearing, are called good results. Those in which there are good stability and motion, but in which either pain or deformity or both persist, though not enough to interfere with walking, are called fair. Loss of motion or stability, pain or deformity sufficient to interfere with walking—*any one of these* denotes a poor result.

Of the ten patients operated upon, nine have been followed up. Five of these were re-examined by one of the writers; two, nine months after operation; two, one year afterward, and one, two years afterward. Four others were written follow-up letters inquiring into motion, stability, deformity, pain, and function. Only one case could not be traced.

The results in five cases were good, with a painless, functioning foot and a return to their former work. Two of the best results were in cases operated upon within four weeks of the injury—one a badly comminuted fracture, the other a transverse fracture through the body which could not be held in position after open reduction.

In two patients the results were fair. Both of these were much improved, but one reported that he could not do work which required long periods of weight bearing by the foot, because of pain; while the other reported that his foot "rolled out" under his leg and that he could not do the same work on the farm as before his injury.

The other two cases are definitely poor results. A poor result was expected in one of these, as there was present a compound, infected fracture of two months' duration. He now has a painless foot, ankylosed in about ten degrees equinus, which is healed and on which he walks very well. On the whole, this might be called a fair result, considering his condition when first seen. In the other poor result, hypertrophic arthritis has caused bony ankylosis, with the foot in moderate equinus and some pain on weight bearing. This woman had a fracture of six years' duration, with much new bone formation about both malleoli. After removal of the astragalus, the arthritic condition continued, to result finally in ankylosis of the new joint.

## CONCLUSIONS

1. Fractures of the astragalus rank with fractures of the os calcis in resultant disability.

2. As the best result from removal of the astragalus is usually rated as giving about 25 per cent. disability in the extremity, open reduction should be resorted to in more instances, thereby eliminating many late astragalectomies.

3. If the reduction obtained by open operation cannot be maintained, or, if the comminution and crushing of the bone is very severe, early astragalectomy is indicated.

4. In late cases of mal-union and of non-union, astragalectomy is the treatment of choice.

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# ACUTE FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

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Surgical literature contains ample discussion and information upon the types and the treatment of fractures and dislocations about the ankle-joint. It is, obviously, needless to duplicate or even summarize that which has



FIGS. 1A and 1B.—Case I, W. B. Showing Compound Fracture-Dislocation of Right Ankle with a bi-malleolar Fracture.

already been so ably presented. It is my desire, however, to present some of the specific complications which are frequently encountered in acute severe fracture-dislocations of the ankle-joint but which are not often emphasized.

Five cases have been selected from a large series of severe fracture-dislocations about the ankle-joint. Rather detailed descriptions of the cases are being presented because they present the most common complications that are encountered in such type of injury.
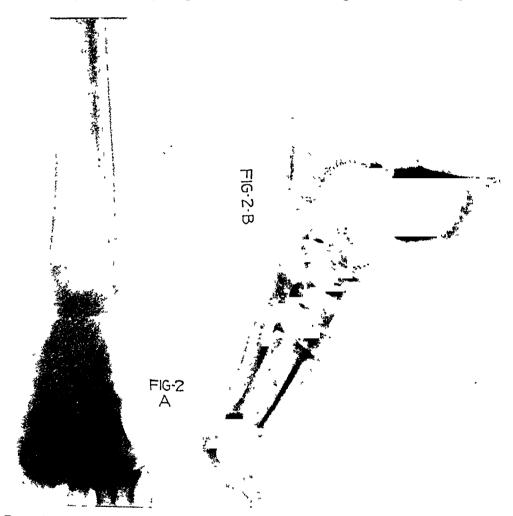
There is no doubt but that the frequency of such type of injury is on the increase. This is due to the increased use of motor driven vehicles, as well as to increased speed of locomotion. It is interesting to note that

three out of the five cases described were injuries incident to the use of the automobile.

The cases and their detailed histories are as follows:

CASE I.—W. B., colored male, steel worker, aged thirty-five years. Admitted to the Orthopædic Service, Employees' Hospital, Fairfield, Ala., August 13, 1925. Patient reported having had a heavy weight fall across feet and legs a few moments previous



FIGS. 2A and 2B.—Case I, W. B. Showing good union and good position of Compound Fracture-Dislocation of Right Ankle.

to admission to the hospital. Examination showed a severe jagged compound wound and fracture-dislocation of the *right* ankle-joint, the wound being on the external surface of the ankle, with the lower end of the tibia and external malleolus protruding.
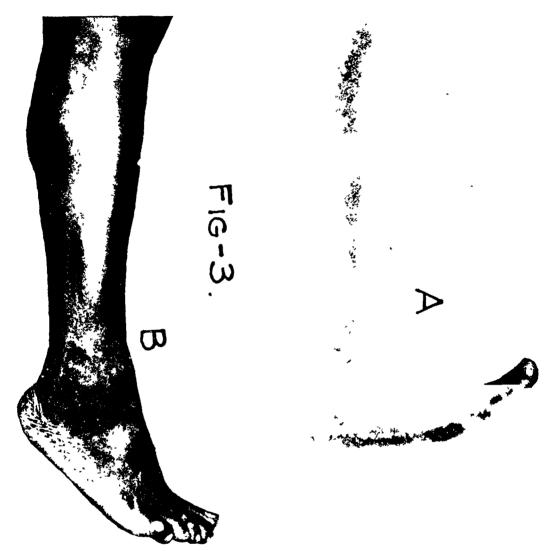
Further examination showed practically a traumatic amputation of the *left* leg through the middle third. Röntgen-ray examination (Figs. 1A and 1B) of the right ankle showed a bi-malleolar fracture with marked displacement and a backward and inward dislocation of the astragalus at the tibial articulation.

Ether anæsthetic was given immediately and the right ankle, foot and the lower half of the leg cleansed thoroughly with soap and water and then large quantities of ether used. The protruding ends of the tibia and the external malleolus were cleansed with Dakin's solution and reduction was immediately accomplished without difficulty.

The compound wound was debrided and closed with deep interrupted chromic catgut sutures and the skin was closed with interrupted silkworm sutures. The foot was placed at right angle to the leg at the ankle-joint, midway between adduction and abduction. Due to the severe injury to the soft structures it was with great difficulty that this position was maintained until a plaster case was applied.

A large amount of circular padding with sheet cotton was applied from the base of the toes to the middle of the thigh, with proper protection of the wound with sterile

FIG-3.

B

A

FIGS. 3A and 3B.—Case I, W. B. Showing perfect functional results of Compound Fracture-Dislocation of Right Ankle.
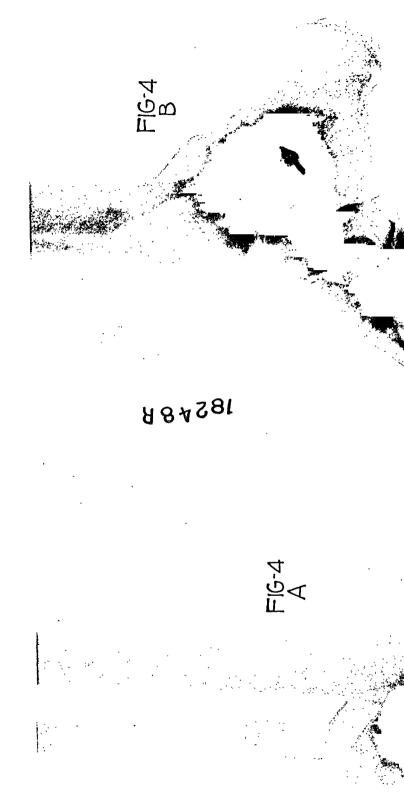
dressings. A circular plaster bandage was then applied with about 20° flexion at the knee-joint. Amputation was done through the middle third of the left leg.

Following the operation on the right leg very close attention was paid to the circulation. At no time, however, did we feel very uneasy about the circulation, because sufficient padding had been used.

Röntgen-ray examination, following operation, showed good position of the fractures. Twenty-four hours following operation a window was cut over the compound wound. The patient had a post-operative elevation of temperature within thirty-six hours to 101° F., which became normal five days following operation. Except for a slight serous drainage from the wound the patient had no infection. The case remained in place for five weeks when the anterior half was removed.

Daily active and passive motion was then carried out with application of local heat

Figs. 4A and 4B.—Case II, L. J. Showing Compound Fracture-Dislocation of Right Ankle.

to the foot and the leg. The posterior half of the case was removed in seven weeks from date of the injury and weight bearing was commenced nine weeks following reduction. Gradual improvement was noted and within four months following injury a röntgenogram showed good union and good position. (Figs. 2A and 2B.) Physical examination of the ankle at that time also showed good functional results. (Figs. 3A and 3B.) An orthopædic heel, with elevation of a quarter of an inch on inner half of heel, supplemented with a felt pad to instep, was added to right shoe when weight bearing was first commenced.

CASE II.—L. J., white male, age forty-six years. Admitted to hospital November 7, 1925, with a history of having been in an automobile accident a short time previous. Examination showed a compound fracture and a dislocation of the right ankle, with the compound wound on the inner surface of the ankle, and the lower end of the tibia protruding through the wound. The foot was very cold and had no circulation whatever.



FIGS. 5A and 5B.—Case II, L. J. Showing good union and fair position of Compound Fracture-Dislocation of Right Ankle.

Röntgen-rays (Figs. 4A and 4B) showed a fracture of the lower third of the right fibula, with considerable overlapping, and also a fracture with marked displacement of the internal malleolus, with an external and a posterior dislocation of the astragalus at the tibial articulation. The compound wound was very dirty and the edges were badly torn. Nitrous oxide-oxygen anæsthetic was given and the operative technic was carried out as in Case I. The post-operative care also was the same as in Case I. The patient was discharged from the hospital December 5, 1925, with case still on leg, but with no drainage from the compound wound.

This patient was observed, at frequent intervals, in the Orthopædic Out-Clinic Department until entirely recovered. The anterior half of the plaster case was removed five weeks after injury and baking with active and passive motion commenced. The posterior half of the case was removed eight weeks following injury.
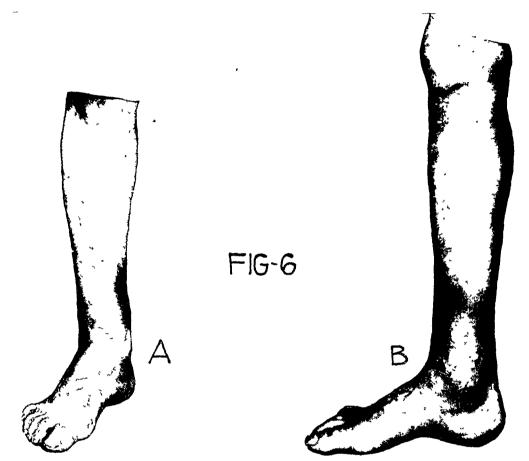
In this patient the compound wound broke down partially and was very prolonged in healing, due entirely to the severe compound wound into the ankle-joint, and also to the fact that it was a street accident, in the author's opinion, thereby having been subjected to greater contamination. The wound did not heal entirely until ten weeks

following injury, due to a low grade osteomyelitis. At no time, however, was the sluggishness of the healing process of the wound considered serious. It, however, was extremely annoying.

This patient had considerable pain on moderate motion which, following removal of case, was relieved, to a certain extent, with tri-daily applications of dry and moist heat.

Nine weeks following injury the patient was allowed to commence weight bearing,



FIG-6

A                                                 B
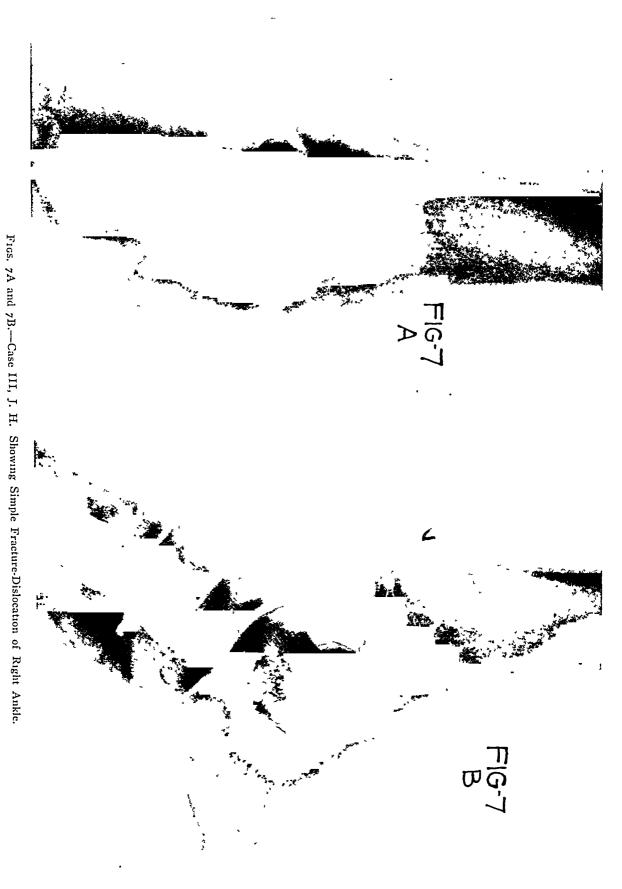
Figs. 6A and 6B.—Case II, L. J. Showing functional results of Compound Fracture-Dislocation of Right Ankle.

at which time he had moderate motion in the ankle-joint, with some instability and considerable pain. By a continuation of the heat and the hot baths the pain in the ankle was considerably relieved. The patient gradually developed a complete ankylosis in the ankle, and not until this occurred was the pain entirely relieved, or full stability of the ankle obtained.

This patient was not able to return to work until six months following injury, at which time, however, he had good union with fair position of ankle-joint. (Figs. 5A and 5B.) Physical examination (Figs. 6A and 6B) showed a practically ankylosed but painless ankle. The patient returned to the same type of work which he was doing at the time of injury.

Case III.—J. H., colored male, miner, age thirty-five years. Admitted to the hospital June 24, 1926, with a history of having had a large rock fall on his legs and feet. The left leg showed a severe compound comminuted fracture of the middle third of the tibia and fibula, or practically a traumatic amputation. The right leg showed a simple fracture-dislocation of the ankle, with marked deformity and intraarticular hæmorrhage.

Figs. 7A and 7B.—Case III, J. H. Showing Simple Fracture-Dislocation of Right Ankle.
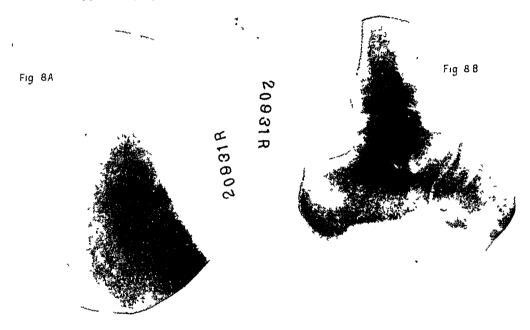
Röntgen-rays (Figs. 7A and 7B) showed a fracture-dislocation. The astragalus was dislocated posteriorly, with a fracture of the inferior articular surface of the tibia, posterior edge.

Ether anæsthetic was given immediately and reduction of the simple fracture-dislocation was accomplished without any difficulty. The foot was placed at a right angle to the leg, midway between adduction and abduction and—after padding the foot, leg and the thigh well—a circular plaster bandage was applied from the base of the toes to the middle of the thigh, with 20° of flexion at the knee-joint. Amputation of the middle third of left leg was carried out at the same time.

On account of the maximum amount of swelling and pressure about the ankle-joint, due to a very marked intramuscular and subcutaneous hæmorrhage, the anterior half of the plaster case was bi-valved along its entire course.

In this type of injury it has been considered best to bi-valve the case to prevent a



Fig 8A

Fig 8B
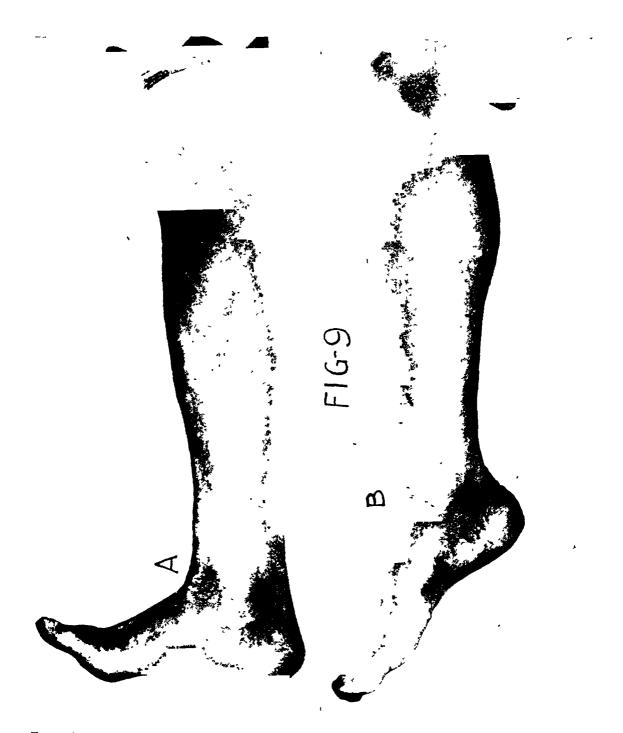
FIGS. 8A and 8B.—Case III, J. H. Showing good union and good position of Simple Fracture-Dislocation of Right Ankle.

further obstruction of the circulation to the ankle and the foot. This is more liable to happen in the simple than in the compound fracture, because drainage takes place in the latter. The bi-valved case was left in place for three weeks when anterior half was removed. Baking with active and passive motion to the ankle-joint and leg was carried out daily thereafter. The patient was discharged July 22, 1926, and frequent observation was carried out in the Orthopædic Out-Clinic Department following discharge.

The posterior half of the case was removed five weeks following injury and hot baths and olive oil massage were commenced. After applying an orthopædic heel and a felt pad to the instep of the right shoe, weight bearing was commenced eight weeks following injury and patient returned to his former occupation three weeks later. Röntgen-rays (Figs. 8A and 8B) showed good union and good position of the fracture-dislocation and physical examination (Figs. 9A and 9B) showed perfect functional results.

CASE IV.—S. R., white male, age thirty-one years. Admitted to the hospital August 22, 1926, with a history of having been injured in an automobile accident a few moments previous. Examination showed a severe compound fracture-dislocation of the left ankle, with the compound wound over the external lateral surface of the left ankle. The lower ends of the tibia and fibula were protruding through the wound.

FIGS. 9A and 9B.—Case III, J. H. Showing perfect functional results of Simple Fracture-Dislocation of Right Ankle.
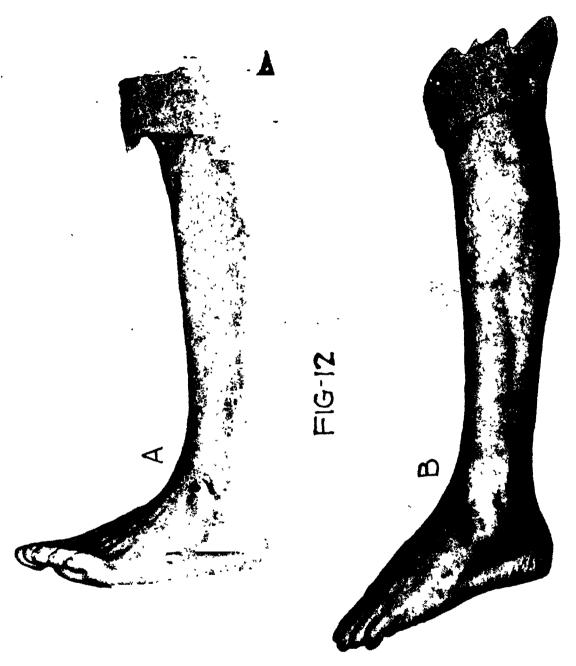
FIGS. 10A and 10B.— Case IV, S. R. Showing Compound Fracture-Dislocation of Left Ankle.



FIGS. 11A and 11B.—Case IV, S. R. Showing good union and position of Compound Fracture-Dislocation of Left Ankle.

Röntgen-rays showed (Figs. 10A and 10B) a fracture-dislocation of the left ankle, with a chip fracture at the lower articular end of the tibia, anterior surface, and a fracture through the body of the astragalus, part of which was protruding through the compound wound. Further physical examination showed the foot was at a right angle to the inner lower surface of the tibia. There was absolutely no circulation whatever in
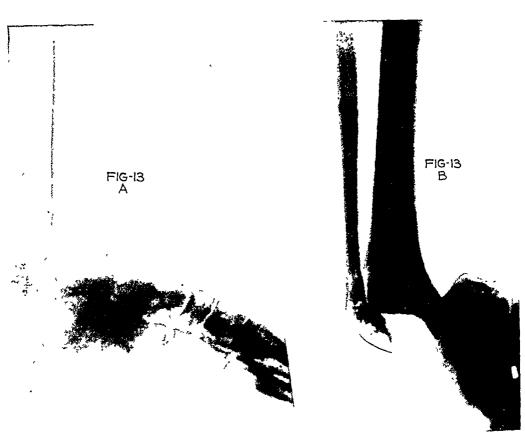


FIGS. 12A and 12B.—Case IV, S. R. Showing functional results of Compound Fracture-Dislocation of Left Ankle.

the foot. Nitrous oxide-oxygen anæsthetic was given and reduction made immediately. The operative treatment was carried out as in Case I.
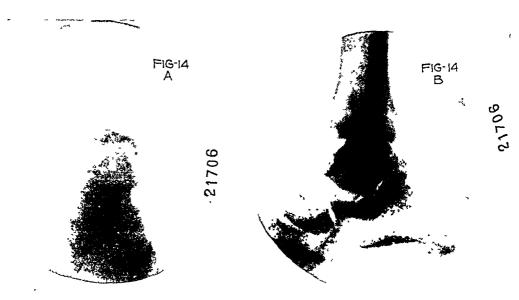
Following the application of the plaster case a window was made in the plaster over the compound wound. The patient had slight drainage from wound, more of a serous type, for ten or twelve days. Other than this he had an uneventful post-operative recovery. He was discharged from the hospital September 24, 1926.

The anterior half of the case was removed in six weeks following injury and active and passive motion carried on daily. The posterior half of the case was removed the

FIGS. 13A and 13B.—Case V, W. S. Showing a Simple Fracture-Dislocation of Left Ankle.
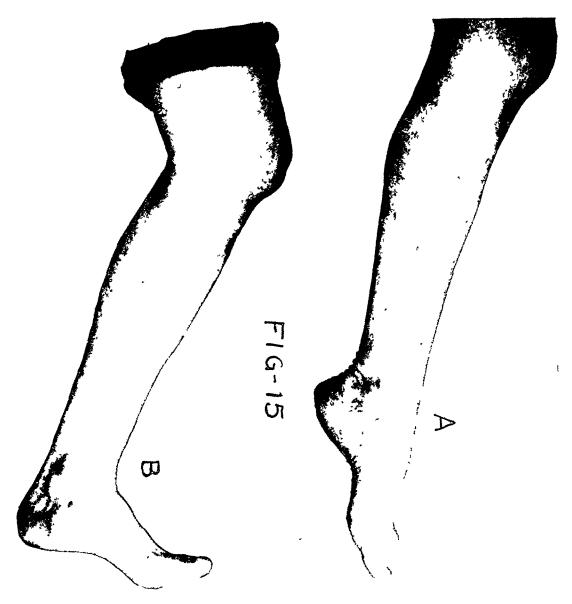


FIGS. 14A and 14B.—Case V, W. S. Showing good union and position of Simple Fracture Dislocation of Left Ankle.

ninth week. Weight bearing, with the aid of crutches, was commenced within ten weeks from date of injury. This patient had considerable pain and tenderness, with instability in the ankle-joint, for four or five months following injury, and not until he developed an ankylosis did all the pain subside, and the instability of the ankle disappear.

Röntgen-rays finally showed good union and good position. (Figs. 11A and 11B.) Physical examination (Figs. 12A and 12B) showed patient had absolutely no pain, some forward flexion and extension of the front part of the foot. He was able to walk



Figs 15A and 15B.—Case V, W S. Showing perfect functional results of Simple Fracture-Dislocation of Left Ankle.

without pain and stated that he was comfortable and doing the work which he was doing at time of injury without difficulty.

If conservative treatment had not been carried out in this case amputation probably would have been necessary. A further economic complication in this case was that this man had suffered amputation of his right arm several years previous.

CASE V.—W. S., white male, age twenty-three years. Admitted to the hospital August 29, 1926, with a history of having been in an automobile accident only a few moments previous. Examination showed a simple fracture-dislocation of left ankle, with marked swelling and deformity. Röntgen-rays (Figs. 13A and 13B) showed a fracture-dislocation of left ankle, consisting of a fracture of lower end of the fibula, with a forward

and inward dislocation of the astragalus at the ankle-joint. Nitrous oxide-oxygen anæsthetic was given and reduction was accomplished without difficulty. The treatment was carried out as in Case III—that is, the circular plaster case was bi-valved all along the course of its application and close observation was made of circulation. The patient was discharged from the hospital September 7, 1926. Frequent observation was carried out in Orthopædic Out-Clinic Department thereafter.

The anterior half of the plaster case was removed in four weeks and active and passive motion commenced, with application of heat to ankle, leg and foot. The posterior half of the case was removed in six weeks and weight bearing was commenced eight weeks following injury. An orthopædic heel was applied. This was raised on inner half one-fourth inch and a felt pad was applied to the instep of shoe, when weight bearing was first commenced. Final Röntgen-rays showed good union and·good position. (Figs. 14A and 14B.) Final physical examination showed perfect function and no disability whatever. (Figs. 15A and 15B.)

## CONCLUSIONS

1. Early attention to all fracture-dislocations of the ankle-joint is important. The earlier the reduction and treatment the shorter the period of convalescence.

2. Thorough mechanical cleansing of all compound wounds and the removal of all foreign material is very important. The use of ether-Dakin technic, in the author's cases, was effective.

3. Conservative treatment should always be carried out before amputation is attempted.

4. In every case soft structures, that is, ligaments, tendons, muscles, and blood and nerve supplies should be given careful attention.

5. Considerable difficulty is usually encountered in maintaining proper position of the foot in relation to the leg at the ankle-joint in fracture-dislocations of the ankle, and fixation in an encircling plaster bandage is the only efficient method whereby this can be obtained.

6. Too early motion in some cases of injury to the ankle-joint is not to be desired. Fixation in a plaster case, over a considerable period of time, to aid repair of the soft structures and to prevent instability of the joint, is very important.

7. Complete ankylosis in certain cases is to be desired more than a painful and unstable ankle-joint.

8. The circulation should be watched at all times, especially in the simple fracture-dislocations where extensive subcutaneous and intramuscular hæmorrhage takes place causing severe pressure.

9. To prevent any possible rotation of the tibia and fibula at the ankle, the plaster case must extend from the base of the toes to the middle of thigh. The foot should usually be placed at right angle to leg, midway between adduction and abduction, with twenty to thirty degrees of flexion at the knee-joint.

10. No weight bearing should be carried out before two months in any fracture-dislocation of the ankle, and an orthopædic heel, with proper elevation to inner half as well as felt pad to instep of the shoe, should always be applied.

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# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 14, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

## DISRUPTION OF SYMPHYSIS-RUPTURE OF THE PERINEUM

DR. CLAY RAY MURRAY presented a little girl, who was admitted to his service at the Lincoln Hospital June 16, 1925. At that time she was three years of age. She had been struck by an automobile, and on admission was in severe shock, unable to walk, and bleeding from the perineum, both ischiorectal fossæ, and the rectum. Examination revealed a complete laceration of the perineum, and a disruption of the symphysis with a two-and-a-half inch separation of the fragments. The two sides of the pelvis were freely movable, the left side lying at a higher level than the right.

She was sent to the operating room, and 400 cubic centimetres of blood were transfused by the Lindemann method. The perineum lay torn widely open. The rectum lay as a loose tube in the wound, but was not itself torn. The vagina and urethra were in similar condition. The central point of the perineum was completely lacerated. The bladder could be seen in the depths of the wound, having no support. The mucosa of the vulva was widely lacerated, requiring extensive suturing to restore it to relatively normal condition. As a preliminary, catheters were placed in the urethra and vagina to obviate operative trauma to these two organs. Sutures were then passed through what should have been the torn ends of the sphincteric muscles of the rectum, and they were united in the region which should have been the central point of the perineum. Similarly, what was left of the lacerated levator ani muscles was sutured. The torn tissues about the base of the bladder were united, and the wounds in the vulva closed, the labia having been torn from their connection with the vagina. Rubber dam drainage was inserted into the lower angle of the wound, and the space of Retzius, which had been widely opened up by the original trauma, was similarly drained.

The patient reacted well post-operatively, but there was no bladder or rectal control. On the nineteenth she had a sharp collapse following the administration of 100 cubic centimetres of 5 per cent. glucose intravenously, from which she rallied rapidly. On the twentieth she was given a transfusion of 200 cubic centimetres of blood by the Lindemann method, with considerable improvement in her condition. July three a plaster spica was applied to the pelvis, including both thighs down to the knees, after the pelvis had been forcibly compressed laterally in an attempt to overcome the wide separation at the symphysis. She was discharged from the hospital August sixteen, wearing the plaster spica, but still without rectal or bladder control.

Following discharge the bladder and rectal condition gradually improved until in about six months she had regained complete control of these organs. But the wide separation of the symphysis persisted with apparent shortening of one and a half inches in the left leg due to the raising of the left side of the pelvis, resulting in a limping gait, and a waddling one, with pain. After

two years of wearing a tight pelvic girdle without benefit she was readmitted to the hospital for repair of the symphysis. After exposure at operation the attempt was made to pull the two sides of the pelvis together with heavy kangaroo tendon sutures aided by lateral compression of the pelvis by an assistant. It did not seem to be sufficiently effective, and a double strand of heavy annealed wire was substituted for the kangaroo and the two bones were approximated to within three-eighths of an inch of one another. Since that time the apparent shortening of the left leg has disappeared, and the patient's gait has become normal, and she plays about with the other children without disability.

Recently the child began to complain of pain on attempted urination. becoming steadily more severe. The urine was negative. An X-ray showed that the original wire suture was now in three pieces, one piece apparently embedded in each side of the symphysis, and a central piece lying behind and below the symphysis. It was suspected that the central piece was responsible for the bladder symptoms, and on operation for the removal of the wire this fragment was found to be imbedded by one end in the bladder wall, though apparently not actually perforating it. On removal of the wire fragments the patient's bladder symptoms disappeared. She seems now perfectly well and normal.

Recent physical examination shows an apparently good rectal sphincter, but a perineum which is practically nothing but scar tissue, a vagina which presents open, the labia being contracted laterally and there being no evidence of a hymen, and an introitus which is a rigid scar tissue ring. This may have considerable bearing on future marital relations and on child bearing.

Dr. Walter M. Brickner showed röntgenograms from a case of traumatic disruption of the symphysis pubis, which also occurred in a little girl thrown down by an automobile, but unlike Doctor Murray's case without injury to any viscus and without any sign of soft part injury. This child had been sent to Doctor Brickner in a temporary splint for the treatment of a fracture of the mid-shaft of the left femur, but examination made him suspect that there was also some fracture in the pelvis. Röntgenograms showed a line of incomplete fracture in the ischium, and a separation of about two centimetres at the symphysis pubis, the right pubic bone being carried away that distance from the mid-line. In any case of separation of the symphysis pubis there must also be a second break in the pelvic ring. It must have been so in Doctor Murray's case although he made no mention of it. This second break may be, c.g., a fracture of the Malgaigne type, or a separation in one of the sacro-iliac joints. In Doctor Brickner's case röntgenograms showed a distinct separation in the left sacro-iliac joint. Under manipulation in anaesthesia the joint separation was reduced with an audible click and the pubes could be felt brought into normal apposition in the mid-line where previously the separation was palpable with the finger tip. Reduction was maintained by adhesive plaster. and by plaster of Paris, involving also the injured lower extremity. The subsequent röntgenograms exhibited show an apparently normal pelvis and very good union of the femur. The child exhibits no limp and is free from all symptoms. At no time was there any urinary disturbance.

## OLD FRACTURE-DISLOCATION OF THE ELBOW

DOCTOR MURRAY presented a man, thirty-nine years of age, who was admitted to the Fracture Service of the Presbyterian Hospital, July 10, 1928. Discharged July 28, 1928. He gave a history of having stumbled and fallen one year previously, cutting the left elbow. Did not consult a doctor, and the cut healed in about three weeks. The elbow was sore for only a short time, but he was never able to use it as before the accident. About four months ago he noticed the arm muscles above the elbow becoming smaller, and about three months ago his elbow began to get so stiff that he could no longer get his hand to his mouth. Three days ago, with no other trauma than his work of driving a car, he began to have pain down the front and back of the arm.

Except for Neisser infection sixteen years ago, lasting five months, and pneumonia with empyema operated on at fifteen years, history is irrelevant. The chest showed an old empyema scar.

The left elbow was swollen and distorted. The whole forearm appeared backwardly displaced, the gross appearance being that of a posterior dislocation of the elbow. There was preternatural mobility of the ulna on the humerus laterally, backward and forward. The elbow was held flexed at one hundred and seventy degrees. There were only ten to fifteen degrees of motion range. The condyles of the humerus had the normal relation to the shaft, but there was a long mass down in front of the internal epicondyle, and apparently attached to it. The head of the radius seemed in normal relationship to the ulna, but in contact with the external epicondyle of the humerus.

Skiagraphs showed backward dislocation of the forearm on the humerus, with fracture of the olecranon. A fragment of the proximal end of the olecranon displaced somewhat upward and rotated forward. Callus is present between the fragment and the shaft of the ulna. This callus involves the joint surface, producing a sort of a hump. In the lateral view two rather long shadows extend obliquely upward across the lower end of the humerus. Two curved, elongated shadows lie on the flexor side of the lower end of the humerus which probably represent calcification in the soft tissues. New bone formation seems to be present on the posterior aspect of the lower end of the humerus.

In no picture or on examination before operation, and on re-examination after the operative findings were known, was it possible to see any evidence of osteomyelitis or joint suppuration.

The temperature on admission was 101°, but under continuous wet dressings became normal and remained so until the day of operation, one week later. All the mild inflammatory symptoms, which were considered traumatic, disappeared. There was no pain or tenderness.

After a two-day preparation he was operated on July 17, 1928. It was designed to do a McAusland type of arthroplasty. It was found that there was union between the fragments of the olecranon only along the outer border. The space between the fragments elsewhere was filled in by dirty, gray, granulation tissue, obviously chronically infected. This cavity communicated directly with the elbow-joint, which contained a moderate amount of cloudy fibrin-flecked fluid. The olecranon fragment was separated and turned up and back with the soft part flap, exposing the elbow-joint from behind. Radial head appeared normal. The joint synovia was thickened and looked like thick purple-red plush throughout. The articular surface of the ulna and the articular surfaces of the humerus showed numerous erosions.

The cartilage was extremely friable, and covered bone in both instances so soft that the fingers could compress it as it would spongy molasses candy. This bone contained scattered areas of greater softness filled with granulation tissue of the same type as described above. Normal feeling and appearing bone was not found until above the level of the epicondyles. The olecranon fossa contained soft bone and the same granulation tissue as heretofore described. A resection of all infected bone of the lower humerus was done, subperiosteal in the region of the muscular attachments in the neighborhood of the epicondyles, and all infected synovia that could be removed from the capsule was removed. The calcifications in the soft parts were also removed. The separated fragment of the olecranon was dissected from its soft part bed, and the articular surface of the remainder of the olecranon and the bone beneath it was removed. The wound was closed in layers very loosely without drainage. The ulnar nerve had been isolated at the beginning of the procedure, and kept out of harm's way on a tape. At no time was anything resembling caseation or tubercle formation seen.

Despite a long operative procedure the post-operative reaction was extremely moderate. July 26 he was measured for a jointed brace to allow of motion only in the anteroposterior plane. Gross appearance excellent. Painless range of motion from eighty to one hundred and thirty degrees. Thin serosanguineous fluid discharging from the centre of the wound. August 6, 1928, the operative wound was closed. Motion ninety to one hundred and thirty degrees. No pronation or supination. Wearing a brace. October 4, 1928, there was slight lateral instability without the brace, but it is well stabilized by muscle control when voluntarily used. Painless range—full extension to flexion of eighty degrees. October 31, 1928, flexion eighty degrees, extension one hundred and seventy degrees, full pronation and supination. No pain.

He has been back at work since the fourth of October, and today did six hours as a plumber and drove a light truck for two hours.

## RUPTURE OF THE AXILLARY ARTERY COMPLICATING EPIPHYSEAL SEPARATION OF THE UPPER HUMERUS

Doctor Murray presented a youth, sixteen years of age, who was hit by an automobile August 30, 1927. He was taken to the Lenox Hill Hospital, where a laceration and abrasion of his right scapular region, contusions of the right shoulder, and an ecchymosis over the mesial aspect of the right upper arm were discovered. He complained at the time of some numbness and weakness of his right hand. The laceration was sutured. An X-ray failed to reveal any evidence of fracture of the humerus or scapula. He was kept under observation for several days, during which time the numbness and weakness of the hand persisted, and some sensory disturbances were found. He was considered, at that time, to have sustained a direct trauma to the cords of the brachial plexus at the site of the ecchymosis, high up over the inner face of the right upper arm. This spot remained tender during his stay. He complained of moderate pain about the shoulder. He was given physiotherapy, and was discharged to neurological observation in the Out-Patient Department.

Apparently he transferred his attentions to Lincoln Hospital where he was admitted September 8, 1927, complaining of pain in the right arm, some shoulder girdle pain, and numbness and weakness in the right hand and arm. He showed localized tenderness and some thickening in the region of the right upper humeral epiphysis, a healing laceration in the right scapular

region, and an ecchymosis as before described, with the addition of a pulsating mass at this site about one inch in diameter. X-rays showed no bony pathology and it was presumed that his tenderness represented an epiphyseal trauma or separation without displacement, as is frequently seen in the young. The mass on the inner side of the arm, close to the apex of the axilla, was diagnosed as a traumatic aneurysm of the axillary artery. There was at this time apparently little or no sensory change in the hand and arm, but some weakness, particularly in flexion. He was having moderate pain in the arm, and complained of it feeling cold. There was no cyanosis and the pulse seemed good. For the next four days he was treated by heat, rest and elevation, at the end of which time the mass, which was flat and pulsating, had increased in size. At this time he was seeing Doctor Murray, who concurred in the diagnosis of aneurysm and advised operation. At that time the mass was about one by two inches, moderately soft, apparently pulsating, and gave a distinct bruit. Shortly after he became suddenly worse, the pulse on the affected side almost disappeared, and pain, numbness and weakness became marked. At operation, when the deep fascia was exposed it appeared bluish, was extremely tense, and the biceps muscle was spread under it in a thin sheet. With the axillary artery controlled, above and below, the deep fascia was incised, and a tremendous clot shot out of the wound, having been under great tension beneath the deep fascia. There was no trace of any aneurysmal sac, but the torn ends of the axillary were ragged and frayed. The vessel had ruptured in its third part, below the subscapular branch. There had apparently existed a false or dissecting aneurysm, which had effected a gradual disruption of the vessel. The soft parts had been considerably stretched and torn by the tension of the hæmorrhage. The ends of the vessel were doubly ligated, all clot removed, the stretched and torn muscle and fascial tissues restored as much as possible to their normal relations, and the wound closed. He has since then been under physiotherapy, and presents now, after fourteen months, a marked improvement, although there is considerable residual palsy, apparently of brachial cord origin. Pressure over the scar gives marked tingling and pain flashes down the arm into the hand. It is highly probable that a large part of the residual palsy is attributable to the effect of scar tissue compression of the cords at the site of the original injury. His condition has been stationary for at least a month. Attempts to aid the beginning contractures of the fingers by the use of elastic traction on a banjo splint have been defeated by the extremely poor circulation becoming compromised by the pressure. The pulse on that side is barely perceptible.

## FRACTURE OF PATELLA—OPEN REDUCTION FOLLOWED BY DELAYED OSTEOMYELITIS

DOCTOR MURRAY presented a girl, eight years of age, who was admitted to the Polyclinic Hospital October 29, 1927. She had sustained fracture of the patella with wide separation of the fragments from a fall down a flight of stairs. She had a temperature of 99.8°, was extremely apprehensive and nervous, and showed a knee-joint full of blood with no surface lesion. The joint was not aspirated. A posterior splint was applied, the leg was elevated, and constant heat kept to it for five days, when an open reduction was done by repairing the tears in the lateral expansions, which were extensive, suturing the synovia by a separate line of interrupted sutures, everting the edges and suturing the fascia over the patella. No sutures were passed through the bone, and no skin sutures were passed, clips being used for skin closure. Profuse dressings without splints and a firm bandage were applied. The

leg was elevated and radiant heat applied constantly. Convalescence was normal. At the end of four weeks she was allowed to go home on crutches, being referred to the physiotherapy clinic for further treatment. Two weeks later she returned to the Surgical Clinic because of a very small opening at lower angle of the wound. A chromic knot was discharged through this in a few days and the wound closed up with no further difficulty. Because she was extremely apprehensive the patient was attending the physiotherapy department for the next two months, motion return being slow. However, she was attending school all this time and was by her own story playing normally with the other children. She had secured a solid bony union.

Three and a half months after her first admission, about the middle of February, 1928, she developed some pain and swelling over the knee. Careful examination elicited signs of nothing except a prepatellar bursitis. She denied any trauma, and there was no evidence of any trouble in the joint itself. However, it was desired to leave her in the hospital for observation, but the parents refused to consider it. She was taken home, and used cold wet dressings, and gave the part rest. By February 27, 1928, the swelling and tenderness had increased, and the parents left her at the hospital. She had a temperature of 104°, and showed a hot, red, swollen knee, the pathology affecting apparently the soft parts in front of the patella. She was sent to the operating room, and a suppurative process in front of the patella at the normal site of the prepatellar bursa was opened and drained. A culture taken at this operation reported a pure culture of streptococcus hæmolyticus. X-ray pictures taken in the next few days showed some erosion of the patella, but no pathology in the joint. On March 1, 1928, the temperature having stayed at or above 104°, freer drainage was done because of the possibility that the patellar osteomyelitis was not draining freely. Dakinization was started at this time. On March 5 a blood culture was negative. On March 6 fluid was demonstrated in the knee-joint, and an arthrotomy was done with the idea of instituting the Willems treatment. A transfusion was given at this time. The temperature was now swinging widely between 98° and 105° each day. The attempt at Willems's treatment was a failure. The patient would not move the joint nor would she allow any passive movement. Dakinization down to the joint cavity was instituted, and a gentle lavage of the joint was done at the daily dressing. By March 12 her temperature was 105.4. She was taken to the operating room, given a transfusion, the patella was sawed through transversely, the halves being turned up and down, and a large posterior drainage of the knee-joint was established in addition. A blood culture taken before the transfusion was negative. Dakinization was resumed, but the patient was given gas for her dressings. Even here she was in a state of collapse before she was anæsthetized. Her temperature went along at 103°, and on March 18 she was given another transfusion. For the next three days her temperature was a bit lower, but on March 24 was again 103°. She was put out in the direct sunlight at this time and for three days her temperature dropped to 101°, but on March 28 was again 103°. She was again transfused and put out in the sunlight. The temperature was running along at 103°, and on April 3 she was again transfused. All this time she was being Dakinized, dressed daily or every second day, and put out in the air and sunshine. On the 7th of April, no change having occurred, and the patient obviously having reached her limit of endurance, she was taken to the operating room and all the drainage tracts and the knee-joint were packed with vaseline gauze, a plaster spica was applied, and the patient returned to the ward. That night the temperature was still up. The next morning it was 99.2° and from then on never went above 100° and

averaged about 99° until her discharge to Seaside about the middle of June, at which time she was up and about on crutches. Her first dressing after the application of the spica was done four weeks afterward. All the drainage tracts had healed and the knee-joint was healed over with bright clean granulations. Another spica was applied for ten days and when it was removed, except for the surface granulating area, which later healed without skin grafting, there was complete healing. She now has a fibrous ankylosis at an angle of about 150 degrees.

Of interest is the question as to the origin of this infection by hæmolytic streptococcus. It is inconceivable that a wound healing by primary union, and a patella healing by solid bony union, this organism could have been introduced at operation and lain dormant, to suddenly break forth three and a half months afterward. The possibility of a hæmatogenous origin for this infection seems very strong, and is worthy of discussion.

Dr. Frank L. Meleney (by invitation) considered the most important question in this case was how the organism gained entrance so as to affect the patella. This must have occurred at one of three times: During the original operation; at the time the chronic suture worked its way out; or, later, just before the time of the last admission to the hospital. The course of the case would indicate that it did not get in at the time of the original operation, for a hæmolytic streptococcus infection usually causes an immediate and rather sudden rise in temperature. The temperature, however, in this case came down immediately after operation. Likewise, from the appearance of the wound, both during the post-operative course and at the time the patient first left the hospital, there was no evidence of infection. Neither does it seem that streptococci could have been introduced at the time the chromic suture came out, or that they could have been in the catgut when it was imbedded. It should be remembered that it is very easy to destroy streptococci in catgut by even incomplete "sterilization" processes. There was certainly no evidence of acute inflammation while the wound was healing after the chromic catgut was removed. The most probable time of infection was just before the acute inflammation developed; that is, just before she entered the hospital the last time. But it is a puzzle how the organism did get in and why it localized where it did. It is common to see cases of such infection where there has previously been traumatized tissue. When patients look back to a previous trauma and attribute that as the starting point, of tuberculous infection, for example, it is impossible to prove that trauma really has been the cause; but almost every surgeon has seen cases in which there has been immediate injury which caused localization of organisms out of the blood.

Doctor Meleney remembered three cases perfectly well. The first was a patient who had a staphylococcus osteomyelitis of the femur. The boy had been at home for some time before coming to the hospital. Just before coming in he had a sore throat. A blood culture was taken and was positive for hæmolytic streptococcus. At the time of operation a pure culture of

staphylococcus aureus was obtained from the femur. On the next day after operation hæmolytic streptococcus was also found in the wound. This was a case of direct injury. The second case was one of fracture of the os calcis. At the same time the patient had a boil on the back of the neck. He developed acute osteomyelitis of the os calcis at the site of fracture three days afterward. The third case had an abscess of the neck and was a very sick man; he showed a positive blood culture of hæmolytic streptococcus. At the time of operation he was turned on his right side in order to expose his lesion and during the operation his elbow was pressed underneath his body in an unusual attitude. This was noted at the time and the point raised with regard to possible localization of the organism at that site. The day after the operation he developed acute signs of arthritis of the elbow-joint and a very severe purulent infection on the second day. This was opened and with his coöperation under Willems's treatment, perfect function resulted.

Apparently, although there was no direct injury to the blood vessels, there was a delay in the circulation of the blood in the part long enough for the organisms to gain a foothold. With these illustrations of trauma preceding joint infection, or rather, during the course of joint infection, where proof is quite good, Doctor Meleney thought it might be assumed that some of these early traumas likewise injure tissues to a point where the organisms going through the blood stream could become localized at the site of trauma. In the case presented the organisms were probably introduced either directly through the skin, or from the throat, without any extensive degree of local inflammation at the point of entrance and localized in the previously traumatized patella.

## PYLORIC EXCLUSION FOR DUODENAL ULCER

Dr. Frederic W. Bancroft presented a man, thirty-nine years of age, who was admitted to the Fifth Avenue Hospital January 9, 1928. Patient has been having indigestion for the past eight or ten years. For the last four or five years he has suffered from a severe epigastric pain coming on one or two hours after meals. The pain is relieved by taking food. The pain is dull usually, but at times is sharp and severe and radiates toward the tenth intercostal space in the back. His blood count was: red blood cells 5,400,000, white blood cells 10,000, polymorphonuclear leucocytes 68, hæmoglobin 110.

The X-ray examination revealed an ulcer on the cap, which extended to within about a half inch of the region of the papilla of Vater. There was no six-hour retention. From the X-ray it was evident that there was too much contraction to attempt any form of pyloroplasty. Any type of subtotal gastrectomy would be difficult because the induration of the ulcer extended so far toward the descending portion of the duodenum that inversion of the duodenum would be an extremely difficult and dangerous procedure. Devine, in January, 1925, advocated the operation of pyloric exclusion. As described by him a clamp is inserted through the avascular zone of the transverse of the mesocolon, and inserted across the stomach at about the reëntrant angle. Another clamp is put over the antrum just distal to the first. The stomach in this region is then cut through and the pyloric antrum is inverted

with a double inverting suture. The proximal portion of the stomach is then drawn through the mesocolon and anastomosed to the duodenum near the duodeno-jejunal junction by a Polya anastomosis. Devine assumes that the mucous membrane of the pyloric antrum, put at rest, will atrophy, and, therefore, the acid-secreting portion of the stomach will be diminished and the ulcer will heal by being put at rest. Dr. Lewis Gregory Cole suggested a modification of this operation, as follows: After cutting across the antrum, Allis clamps are inserted onto the antrum—opening it wide. The mucous membrane is then dissected free and excised over the entire pyloric antrum down to the pyloric muscle. The stump of the mucous membrane is closed with an inverting suture. The muscularis is closed over it, and peritonealization accomplished by an inverting suture. This procedure removes the acid-bearing mucous membrane, allows an easy and satisfactory closure of the pyloric end, and is not as difficult a procedure as a subtotal gastrotomy. The remainder of the operation is performed as described by Devine.

This operation has been performed four times. In the first three cases there was considerable ooze in the dissection of the mucous membrane from the pyloric end. In the last case this was controlled by inserting a clamp beneath the pylorus and drawing through a rubber band which was tightened, acting as a temporary tourniquet for the vessels in the region of the pylorus. In this case dissection was easy, with very little ooze.

This operation was performed on this patient January 13. He was discharged from the hospital on his nineteenth post-operative day. His convalescence was uneventful. Since that time he has gained twenty pounds in weight, works twelve hours a day in a grocery store, and has no symptoms of any indigestion. Doctor Cole's report of the X-ray findings on January 31, 1928, are as follows: Films of the stomach immediately and four and a half hours after a barium meal show the remaining portion of the stomach and the anastomosis between the stomach and the jejunum. The barium starts out of the stomach immediately without any obstruction or delay. The loops of the anastomosis are shown distinctly. There is a slight angulation at the superior border of the anastomosis due to the distal loop of jejunum dropping or pointing downward. At four and a half hours there is considerable gastric retention. We believe this is due to a twist or angulation in the region of the stoma and not due to a constriction or definite obstruction. At twenty-four hours the stomach and small intestines were entirely empty. The proximal half of the lumen of the appendix is very narrow and filled and directed upward. This region, however, is movable under fluoroscopic manipulation.

The X-ray findings of May 1, 1928, are as follows: Films of the stomach made immediately and six hours after a barium meal show the stoma functioning normally and the stomach empties itself within the six-hour period. The slight angulation in the jejunum at the site of the stoma is the same as reported previously. The cicatricial deformity of the cap is still present and this fills by the barium going backward through the proximal loop of the anastomosis. There is no X-ray evidence of an ulcer at the stoma.

This operation has a certain definite indication in cases of duodenal ulcer where the ulcer extends along the second portion of the duodenum and wherein inversion of the duodenal stump would be difficult and hazardous because of its proximity to the papilla of Vater. The operation is of less risk than the subtotal gastrectomy because of the easy closure of the pyloric

antrum, and the fact that the blood supply in the lesser and greater curvature is very little interfered with. This case is presented to illustrate an operation which is of value in a limited type of case. It is admitted that there is not sufficient length of time for follow-up to determine what its late results will be; but until now the patient's post-operative course and convalescence have been very satisfactory.

## ADENOMYOMA OF RECTOVAGINAL SEPTUM

DR. FREDERIC W. BANCROFT presented a woman, thirty-eight years of age, because this lesion is usually mistaken for malignancy of the rectum, and usually an extensive operation is performed which is not always necessary. She was seen by him first in January, 1927. This case was reported in detail in *Surgical Clinics of North America,* in the New York number, October, 1928.

## VARICOSE VEINS

DR. FREDERIC W. BANCROFT said that in the present day of sheer stockings, short skirts and bare legs in bathing suits, varicose veins or scars on the legs following operation for varicose veins are considered unsightly. For this reason any method that will obliterate veins without operative procedure is to be seriously considered.

Varicose veins may be subclassified into the following types: (*a*) Varicose veins without infection. (*b*) Varicose veins with infection. (*c*) Varicose veins with ulceration. (*d*) Varicose veins with ulceration and arteriosclerosis. (*e*) Varicose veins compensatory to (1) deep obstruction, (2) pressure from pregnancy or tumor in pelvis, (3) cardiovascular decompensation.

Obviously, varicose veins with infection and varicose veins due to compensatory hypertrophy on account of deep obstruction are inadvisable for this type of treatment. Varicose veins without infection and varicose veins with ulceration are satisfactorily treated. The theory of the injection treatment is that the drug acts as an irritant and causes obliteration of the intima.

During the past year over twenty cases of varicose veins had been treated by Dr. Stanley Brown, at the speaker's instigation, in the Out-Patient Department of the Fifth Avenue Hospital, by the injection method.

The average case requires four to six injections, but a few more difficult types require from eight to ten.

In this series of twenty cases all but one had been treated with sodium salicylate. The patient is put in a sitting position, with the leg dropped over the table. A small hypodermic needle is then carefully inserted into the lowest radicle of the dilated vein. Care should be taken to see that the needle is within the lumen of the vein. The leg is then slightly elevated, so that it is empty, and two to five cubic centimetres of a 20 to a 40 per cent. solution of sodium salicylate slowly injected. At the first injection it is the custom to use one cubic centimetre of a 20 per cent. solution of sodium salicylate to test out whether the patient has any idiosyncrasy to salicylates. If no idiosyncrasy is present, five days later one to three cubic centimetres of the

40 per cent. solution may be used. The patient is kept quiet for about ten minutes, after which she is allowed to go home without wearing any bandage.

Following the injections the patient generally feels a burning sensation along the course of the vein. There may be a cramp in the muscles of the calf, but this lasts only for a minute or so. Occasionally a periphlebitis, with some tenderness and induration along the course of the vein, occurs. Wet dressings applied at night usually relieve discomfort, and it is not necessary for the patient to remain in bed. In three of their cases they have had small sloughs at the region of injection, as there was some leakage from the vein or the needle was not satisfactorily inserted.

Doctor Bancroft then presented five cases to illustrate this method.

## FACIAL PARALYSIS AND ITS SURGICAL TREATMENT

Dr. Hermann Fischer read a paper with the above title, for which see page 334.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD DECEMBER 3, 1928

The President, Dr. Astley P. C. Ashhurst, in the Chair

Calvin M. Smyth, Jr., M.D., Recorder

## STENOSIS OF THE COMMON BILIARY DUCT IN AN INFANT

Dr. John O. Bower, by invitation, remarked that in the Annals of Surgery, July, 1928, he reported a case of "Congenital Absence of the Gall-bladder, Cystic and Common Ducts." The review of the literature was as complete as the library of the College of Physicians permitted and included a case reported by Bergman in the year 1701 and one by Littre in 1705. During the investigation a large number of cases of Congenital Stenosis of the Common Duct were found. The majority of these were associated with absence of the gall-bladder and absence and stenosis of the hepatic and common ducts. Most of these anomalies were discovered at autopsy. A few were operated upon. Theodor in 1908 reported the case of a male child, six weeks of age, on whom he did an hepatico-colangio-enterostomy, who died eight days after the anastomosis. The gall-bladder and cystic duct were absent. In 1913, Toygaus operated upon a five-year-old girl for jaundice and abdominal pain who had an obstruction close to the Papilla of Vater—the gall-bladder, cystic and common ducts were enlarged. He thought that there must have been a congenital narrowing or valve-like obstruction in the common duct. A cholecystectomy was first done but the child became progressively weaker. Four months later the common duct was anastomosed to the duodenum and the child became strong and well. In 1927 Derwissieu operated upon a child, female, two and one-half years of age for suspected hepatic echinococcus cyst. Cholecystostomy was done with a stormy convalescence but no jaundice. The fistula did not close for six weeks and attempts to close it resulted in pain and bile retention. Cholecystogastrostomy was then attempted but the child died. Autopsy revealed that the choledochus was .5 centimetre in length and that a fold or obstruction was situated at the junction of the right hepatic and common ducts. These were the only cases that the reporter could discover that were operated upon for congenital stenosis of the common duct. He then reported the following case:

A child, twenty-one months of age, with a perfectly negative history as to delivery and up until the age of one year when she developed bronchitis accompanied by a slight fever and cough. She was not confined to bed. At the end of several days a gradually increasing jaundice developed. This was associated with abdominal discomfort. The child flexed her thighs on

the abdomen and refused to lie in the prone position. She vomited constantly. Urine became dark in color and stools were constipated and of clay color. This was of two months' duration. She was then taken to the Children's Hospital, where, following medical treatment, the jaundice disappeared in ten days. Following this she was well for six months. About August, 1927, she had an attack similar to the first; the jaundice was preceded by bronchitis and accompanied by abdominal pain. There was no



constricted duct

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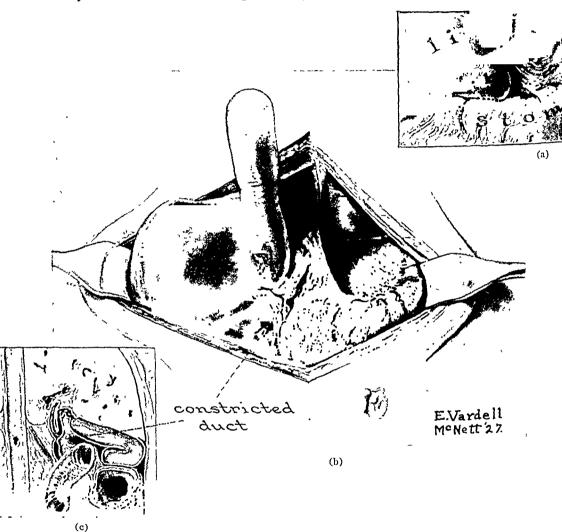
Fig. 1.—Illustration Showing (a) Cross-section of Abdomen with Acutely Flexed Gall-bladder and (b) Constricted Duct and Elongated Gall-bladder Protruding from Abdominal Incision and (c) Anastomosis of Gall-bladder to Stomach.

loss of weight. She was admitted to the Samaritan Hospital on August 12, 1927, with marked jaundice, abdominal pain, putty-like stool and dark urine.

Gastro-intestinal X-ray was negative. Twenty-four hours prior to operation the temperature was 105 by rectum, pulse 150. Immediately before operation temperature was 102.6, pulse 140. At operation August 27, 1927, under ethylene oxygen combined with novocaine anæsthesia, a moderate amount of slightly blood-tinged fluid was found in the peritoneal cavity. There was no evidence of fat necrosis. The stomach was normal in size; duodenum normal, no adhesions. Gall-bladder was not visible but covered over by omentum which was not adherent. The index finger directed posteri-

orly showed the gall-bladder acutely flexed upon itself from above downward. Upon releasing the kink the fundus of the gall-bladder immediately presented itself about one centimetre outside the abdominal wound. It was markedly tense, cylindrical in shape and projected about three centimetres above the edge of the liver. It was about fifteen centimetres in length. No calculi were felt. The cystic, common and hepatic ducts were distended. The common duct was stenosed directly below the junction of the cystic and common ducts. A finger in the foramen of Winslow disclosed no pathology. The pancreas was slightly swollen. The liver was slightly larger and darker than normal, surface mottled but there was no visible evidence of cirrhosis. The gall-bladder wall was grayish-blue and about three times its normal thickness. About forty cubic centimetres of bile were removed by aspiration. An anastomosis of the lateral aspect of the fundus of the gall-bladder, beginning about 1.5 centimetres from the extreme, was made into the stomach directly proximal to the pyloric vein. The opening was about 1.5 centimetres. A cigarette drain was placed directly below the anastomosis and the closure was com-



Fig. 2.—Photograph of Child Fifteen Months After Operation.

pleted with chromic catgut and interrupted sutures of silk. Directly following the operation the child was given thirty cubic centimetres of mother's serum intramuscularly. Enemas containing twenty grains of calcium lactate, four drachms of glucose and three ounces of water were given every three hours. Twelve hours after the operation the child vomited bile-stained mucus, and twenty-four hours after operation bile-stained fluid was siphoned from the rectum. Thirty-six hours after operation she passed a liquid green stool and at the end of forty-eight hours expelled considerable flatus. Forty-eight hours after operation the temperature was 99.4, pulse 100. Following this, there was a slight rise in temperature and pulse which gradually dropped to normal within four days. Fluids were given by mouth and gradually increased until at the end of seventy-two hours the child was taking semi-solid food. The drain was removed on the fourth day. Following this the child's recovery was uneventful. The wound healed primarily and the child was discharged from the hospital October 5, 1927.

She returned to the follow-up clinic, January 25, 1928, and radiographs were taken following the administration of bismuth. No evidence of bismuth

could be demonstrated in the gall-bladder. Fifteen months after operation the child is in excellent health, has had no recurrence of jaundice, stools and urine are normal.

DOCTOR BOWER added that in attempting to correlate the symptoms and signs present in this case with the pathology found at operation, two pertinent questions present themselves. First, if a stenosis of the common duct was present at birth why should the development of symptoms be delayed for a year? Second, what part did the acutely flexed fundus play in the pathology? Regarding the first point it seems to be a well-established fact that a very close relationship exists between the quantity of the end products produced by the liver and the amount required to adequately supply the physiologic needs of the body. This is clearly demonstrated in the reports reviewed. One infant lived 216 days; another 150 days with complete absence of the gall-bladder, cystic, common and hepatic ducts, and the average duration of life for the thirteen cases reported was seventy days. Absence of the gall-bladder, cystic and common ducts is compatible with normal existence, if the hepatic ducts empty into the duodenum. Cases have been reported in which the anomaly was found to be present in patients operated upon for conditions other than biliary disease. Several of them had passed their sixtieth year. It would appear from the cases cited that individuals with congenital defects in the biliary passages can maintain an apparent physiologic balance until certain conditions arise which interrupt it. It will be recalled that in the case reported the two attacks of jaundice were preceded by a respiratory infection. Regarding the second point the speaker believes that the acute flexion of the gall-bladder was a sequence of common duct obstruction due to infection. It could not be confused with torsion of the gall-bladder, similar to the eighteen cases reported by Sutter in 1925. These cases occurred in adults and were usually associated with gall-bladders having long mesenteries. Neither could it be confused with the acute flexion as reported by Bartel (forty cases) in which a groove began below the tip, vertical to the long axis of the gall-bladder and extended over half its surface, giving the gall-bladder the appearance of a tobacco pipe; these cases were observed in adults and were not associated with jaundice. Acute torsion and flexion can therefore be ruled out in this case.

### ENTEROTOMY FOR INTESTINAL OBSTRUCTION

DR. JOHN B. FLICK remarked that not infrequently, in acute intestinal obstruction, the propulsive power of the overdistended gut above the block is so impaired that even after the obstruction is relieved the fæcal contents and gas remain stagnant. Absorption of this highly poisonous material constitutes the greatest danger. It is logical, therefore, in certain cases, even if enterostomy is to be performed, to first empty the intestines as completely as possible. In the cases herein reported the performance of enterotomy became almost a necessity because of inability to replace, without risk of injury, distended intestine which had been forced through the abdominal wound.

# ENTEROTOMY FOR INTESTINAL OBSTRUCTION

The first case, a negro thirty-nine years of age, was admitted to the Pennsylvania Hospital August 29, 1927. He gave a history of appendectomy with drainage one year previous. He apparently had had an obstruction for five days as indicated by his history. After gastric lavage and hypodermoclysis his abdomen was opened. The peritoneal cavity contained a large amount of clear amber fluid. During exploration small intestine escaped through the wound and could not be replaced. The obstruction was due to a band of adhesion running to the cæcum just above the appendectomy scar under which a loop of intestine had been caught. This was divided and the collapsed bowel distal to the point of obstruction was at once seen to fill. A small incision was made in the ileum and about a quart of liquid fæcal matter and much gas emptied out. The incision in the ileum was closed by a purse-string suture and this inverted. The abdomen was closed without drainage. A tube of the Rehfuss type was introduced into the stomach on the following day and left in place. The patient died seventy-two hours after operation. The autopsy showed distention of the stomach and intestines except the colon which was contracted. The intestines were described as dark in color and matted together by thin fibrinous adhesions with marked kinking. No leakage had occurred at the site of enterotomy, but on careful examination a small amount of pus escaped from the holes made by the sutures.

This patient obviously was operated upon too late and perhaps should have received the possible benefit of an enterostomy, after emptying the bowel.

The second case, a negro twenty-six years of age, was admitted to the Pennsylvania Hospital January 26, 1928. He gave a history of an operation for appendiceal abscess in 1918 and for intestinal obstruction in 1926. He apparently had had a partial obstruction for eight days which now was complete. He had a small bowel movement following an enema forty-eight hours before operation. When the abdomen was opened there was considerable free fluid in the peritoneal cavity. The obstruction was due to a band of adhesion under which a loop of small intestine had been caught. This was divided. The small enormously distended intestine was emptied through a small incision in the ileum. Over two quarts of fluid and much gas escaped. The opening was closed with two rows of o chromic gut sutures. The intestine was replaced and the omentum pulled down over it. The abdomen was closed without drainage. The patient was given 500 cubic centimetres of normal saline solution intravenously. He made a good recovery.

The third case, a negress forty-nine years of age, was admitted to the Pennsylvania Hospital August 27, 1928. She gave a history of two previous operations, one for a kidney and the other for a pelvic condition. Rectal examination failed to reveal a growth. She was well until sixteen days before operation when she developed sharp abdominal pains and vomiting. She continued to pass gas until about two days 'before operation. When the abdomen was opened both large and small intestine were found congested and enormously distended. Several coils of small intestine at once escaped from the abdominal cavity. On puncture much gas escaped and a small amount of liquid fæcal matter. The opening in the small intestine was closed with two rows of o chromic gut sutures and the intestine returned to the abdominal cavity. The distention was sufficiently relieved to permit satisfactory exploration. A hard growth was felt in the lower sigmoid. A left inguinal colostomy was then done, the bowel being opened at once and a mushroom catheter fixed in place. The original abdominal incision

was closed without drainage. The patient made a good recovery except for wound infection and left the hospital refusing operation for removal of the growth.

Dr. Damon B. Pfeiffer remarked that he had come to regard enterostomy or jejunostomy as of the greatest value in those conditions which follow inflammatory conditions in the lower abdomen, such as peritonitis or tubal infection. In such conditions there is a time post-operatively when the intestines are matted together by plastic lymph; they become knuckled about the drainage which has been inserted and as a result of paralysis due to infection and distention, the coils are caught in lymph and there develops a more or less marked obstruction, and yet the patient's condition may be entirely satisfactory so far as the infection itself is concerned. The infection may be limited to the field of operation and still be accompanied by obstruction symptoms. If the patient survives, the intestines may liberate themselves in a few days and there is then no further trouble with the passage of bowel contents. However, the condition may become acute and it is not possible to wait for this to relieve itself, and this is where enterostomy seems to be a life-saving procedure. In the last few months he had met with cases in which he felt that the patients would not have recovered without enterostomy. A few days after the obstruction subsided; nothing was passed by the tube which was then removed, and the wound was closed without leakage. Recently, he used this procedure as a prophylactic measure in a case of pelvic abscess of unknown origin. It was necessary to drain the abscess and it seemed that the measures necessary to establish this would cause distention and death unless relief of tension in the bowel was provided for. In that case the procedure was of great value. So far as immediate enterostomy for intestinal obstruction he had always felt that there was a great danger because of the possibility of causing peritonitis. There is no rule more binding on the surgeon than the one not to do an anastomosis in obstruction. If one makes an enterotomy and then closes it up, the patient is submitted to the possibility of fluid and gas causing pressure, as happened in the first case reported by Doctor Flick where there was tension on the sutures, with leakage and peritonitis. The speaker distinctly preferred enterostomy, the opening protected by a piece of omentum.

Dr. George M. Dorrance said that he had been confronted by cases after appendix lesions with acute obstruction low down in the ileum about six inches above the ileocæcal valve—as in Doctor Flick's last case. He thought if the cæcum could be delivered and a cæcostomy made placing a catheter into the ileum to relieve pressure, it would be desirable. In one case the procedure had worked very well. The catheter may be easily slipped through the ileocæcal valve into the small intestine. In appendiceal cases with obstruction low down he intends to use this procedure, rather than the higher one. It is well known that when these appendiceal cases get a fæcal fistula they get well.

# ENTEROTOMY FOR INTESTINAL OBSTRUCTION

DR. EDWARD T. CROSSAN said that in 1920 Doctor Codman wrote a paper on intestinal obstruction in which he reported twenty-seven cases without a death. In this paper he advocated enterotomy and said he thought it a life-saving procedure. The speaker's own experience has been that it was not worth while. Doctor Codman did an enterotomy in all his cases but in eight it was combined with enterostomy. As to intestinal obstruction following acute appendicitis Doctor Crossan recently tried to separate the adhesions in a case of this type and the following day the patient had an intestinal obstruction and he had to do an enterostomy.

DR. HENRY P. BROWN, JR., said that in view of the fact that the toxic manifestations of obstruction are due to absorption from the bowel, that any method which will empty the bowel of its toxic contents will correspondingly diminish the resulting toxæmia. Evacuating the bowel of toxic contents in acute obstruction has recently been suggested. He had adopted this procedure several times with very gratifying results. In one recent case of acute obstruction of the terminal ileum of twenty-four hours' duration, the patient being quite toxic, after relieving the obstruction, a rubber clamp was placed below the site of the obstruction, and a catheter was sutured in the bowel just above the clamp. After greasing the hands and grasping the first part of the jejunum between the index and middle fingers of the right hand the assistant pulled the entire small gut through the reporter's fingers down to the site of the clamp, thus emptying the bowel of its gas and toxic contents. The catheter was then removed, the opening in the bowel closed, and the abdomen sutured in layers without drainage. Aside from slight post-operative nausea from the anæsthesia, the patient never vomited, the temperature was never above 100, and he made a good recovery. This procedure empties the bowel of its gas and toxic contents more efficaciously than when merely an enterostomy is performed.

DR. ASTLEY P. C. ASHHURST said: *First,* as regards enterotomy for acute intestinal obstruction; about twenty years ago or more Moynihan advocated efforts (during the operation) to secure evacuation above the obstruction by opening the bowel about a foot (30 cm.) or higher above the point of obstruction (after relief of the obstruction), inserting a glass tube and crowding on the tube as much bowel as possible. Moynihan said that upon a tube six inches in length six or ten feet of intestine could readily be drawn, the contents evacuated through this tube, the intestinal opening closed, and the bowel replaced. The speaker has tried this method but never could succeed in getting more than one coil of small intestine upon the tube at one time, nor in securing any evacuation. *Second,* as to *enterostomy* (jejunostomy or ileostomy) at the same time as the original operation, or subsequently because the patient was not doing well: Doctor Ashhurst has never had any success at all with this method, as a secondary operation—the bowel simply did not drain, and the patients died. As a primary operative procedure, he has had one temporary success: by opening the first distended coil of bowel that presented, he saved a woman from immediate

death, but she lived only about four months, never regaining sufficient strength to justify a search for the site of obstruction and closure of the fæcal fistula. It is a good rule in intestinal obstruction never to make the incision in the mid-line or near it, if the abdomen is much distended. In cases with great distention it is safer to make the incision to one side or other, according to the indications, and to do an enterostomy, a cæcostomy or a sigmoidostomy above the site of obstruction, but without any search for the latter. If the patient survives, as many of them will do when the obstruction is in the large bowel, the obstructing lesion may prove amenable to a secondary operation. If one opens in the mid-line, when the abdomen is much distended. one must be prepared to do something to the small intestines when they prolapse. They will become much more distended as soon as they escape, and it will be extremely difficult to replace them. Multiple needle punctures may evacuate enough flatus to enable the surgeon to reduce them, but usually the patient does not survive. When the greatly distended bowel is opened in the presence of acute obstruction it is very difficult to prevent peritonitis unless the bowel is kept outside of the abdomen permanently. Even if the wound in the bowel is carefully sutured and does not leak subsequently, there is very apt to be enough contamination during the operation to produce peritonitis subsequently. This may have been what occurred in Doctor Flick's first patient, the case in which the intestine was closed so nicely, no leakage occurring, but the patient dying of peritonitis all the same.

Dr. John B. Flick said that it was because of the great difference of opinion concerning enterotomy that he had thought it would be worthwhile to report these three cases. Among those who believe in it is Moynihan, who states in his book that no operation for acute obstruction can be considered complete which leaves an overdistended intestine whose function it is to absorb contents of a poisonous nature. He advocated enterotomy and does not seem to fear contamination or peritonitis. All three of the reported cases were acute obstruction. One may have been chronic obstruction but it was acute at the time of operation.

## SURGICAL TECHNIC

Dr. Walter G. Elmer read a paper with the above title, for which see page 328.

Dr. Astley P. C. Ashhurst remarked that many of the breaks in technic which Doctor Elmer has suggested may be avoided by foresight. Of course all the dressings and other materials to be used in an operation are supposed to be sterile when they come from the sterilizers; but they should be proved to be so before they are used. Every time the autoclave is put into use at the Episcopal Hospital, and at the Orthopædic Hospital, a package is sent from the centre of the autoclave to the laboratory; and every time the water sterilizer is refilled and the water is sterilized, a sample of the supposedly sterile water is sent to the laboratory; and neither the

gauze, etc., from the autoclave nor the water from the sterilizer is permitted to be used until the laboratory has sent a report that the samples give no bacterial growth on culture media after incubation for forty-eight hours. He regards these precautions as important.

Clean operations should be done early in the day, when possible, leaving the infected cases, such as prostatectomies, operations for pyothorax, etc., until the last. The "suture nurse" should act only as a distributing station, and never as a receiving station. Never let the nurse have any instruments in her hand, except such as she gets from her own table. The instruments which the speaker uses are handled by no one but himself. The nurse hands out from her own table the fresh needles, etc., but when the operator is through with them they are placed in a pan where she cannot reach them. The nurse changes her gown and gloves for every operation, just as the surgeons do. Any blood stains on the sheets under the patient should be covered with something dry (and sterile) as soon as possible, and before anything touches them. Instead of washing his fingers in sterile water, the speaker prefers to use bichloride of mercury solution, because in this way a little bichloride of mercury is carried into the wound each time; before intraperitoneal manipulations, the bichloride may be rinsed off in saline solution. In abdominal surgery there is little chance for the draping sheets, etc., to become displaced, because the patient's position is not changed during the operation. This is not true in fracture surgery because in operating on limbs it is often necessary to move them, and great care is necessary that no unsterile skin area become exposed, and thus permit infection of the wound. With equally careful technic, infection is no more apt to occur in fracture work than in abdominal operations.

Dr. Deforest P. Willard said that he had followed out for years the plan of keeping the wound or the supposedly sterilized surface away from the table by the use of a rubber sheet. He recalled one case in which the technic slipped up and in which he did not use the rubber sheet in which case, obviously, infection developed from the sandbags under the patient. Following an operation on the tendo Achillis the patient was turned over in order to do the bone work on the front part of the foot. Three days later the tendo Achillis wound broke down. The wound on the front of the foot remained clean. Doctor Willard felt sure that the slight amount of blood oozing from the tendo Achillis wound stained the sheet over the sandbag and enough came through to cause the infection. In operations on the extremities the greatest care is taken to see that instruments and sutures do not drag over the skin. The easiest way to protect the wound and sutures from infection is to cover the extremity with a sterilized stockinet. The incision is made through the stockinet and it is sutured to the edge of the wound so that at no time during the operation do the sutures or instruments touch the skin.

# BRIEF COMMUNICATIONS

## BRAIN ABSCESS SPATULÆ

In those instances in the management of brain abscesses where it seems advisable to use drains made of rubber tissue or rubber tubing there arises the difficulty of placing the drain accurately and carefully to the proper depth in the cavity. It is highly important that such a step be done under direct vision, not only that the drain be placed in the depths of the cavity, but that multilocular pockets shall not be overlooked. The various brain abscess "finders" now in use have the disadvantage that the accompanying drains are not inserted directly under vision. Withdrawal of a needle once in an abscess in order to incise the cortex down to the cavity not infrequently results in "losing" it.
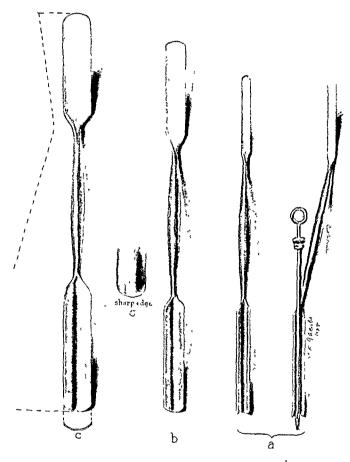
The use of the three pairs of concave spatulæ of graduated sizes, shown in the accompanying sketch, is offered as an effective means of visualizing the depths of a cavity and obviates the hazards of "losing" a cavity by withdrawing a needle once in place.



Fig. 1.—Brain Abscess Spatulæ.

The smallest pair of spatulæ (a) are gently passed, one at a time, down the sides of the needle to the proper depth. After removing the needle a small glass suction tip is used to empty the cavity in part until an idea of its size can be obtained. If it is a large one the second pair of retractors (b) are then inserted about the first pair and so on. By this means the cavity can be thoroughly inspected and a drain of any size carefully placed.

William P. Van Wagenen, M.D.
*Strong Memorial Hospital, Rochester, N. Y.*

# VOLVULUS OF THE CÆCUM

M. S., male, age forty-one, was admitted to St. Joseph's Hospital of Baltimore July 1, 1924, with pain in abdomen, vomiting and inability to get bowels moved.

*Personal History.*—General health good; mumps, measles, chicken-pox in childhood. Gastric ulcer since 1917. Several hæmorrhages. No other serious illness. Has had multiple fibromata molluscæ of body, head and extremities since childhood, Von Recklinghausen's disease. No history of constipation. Present illness: June 28, 1924, afternoon was taken with cramp-like pains in abdomen. Thinking exercise would relieve them, he played golf vigorously for several hours. Pains persisted until 1:30 A.M. next day when he sent for his physician; enemata were ordered but were ineffectual, pains continued throughout the day, and following day. About 1 P.M. of July 1 he began to vomit and to have hiccough. With the onset of hiccough and vomiting, the pains in the abdomen became somewhat less and he began to have heartburn and abdominal distention. He was then sent to St. Joseph's Hospital.

On admission his pulse was seventy-two, mouth temperature ninety-seven Fahrenheit, rectal temperature ninety-nine and two-tenths Fahrenheit, respirations, thirty. He was a well-developed, well-nourished white man.

His abdomen was somewhat distended, liver dulness obscured by tympany; spleen and kidneys not felt.

No tenderness anywhere except over right side at level of the umbilicus. No dulness in flanks.

On tapping over right lower quadrant a splashing and sense of fluctuation is made out. Peristaltic sounds not heard.

On opening the abdomen by incision, outer border right rectus muscle, the small intestines were all distended but with marked constriction at the junction of ileum and cæcum.

A large fluctuant tumor filled the abdomen, extending from the right hypogastrium upward and across abdomen, pressing against the diaphragm on left side. This tumor, size of a watermelon and similarly shaped, was delivered and found to be an enormously dilated cæcum filled with liquid feces, measuring forty-five centimetres long and thirty centimetres in diameter largest part; mounted on this is the appendix; the tumor is dark red, almost purple, and in places small islands, green in color, indicated gangrene. A marked constriction was found at the junction of the ileum and cæcum and also at the ascending colon with cæcum, due to a twisting of the cæcum at these two points, the direction being from right to left, on patient, clockwise, almost a complete turn.

The tumor was untwisted, the entire cæcum was cut away from the ileum beyond the line of constriction, and also in same manner was divided from the ascending colon, preserving as much of the mesentery and vessels as possible.

The cut ends of the intestines were inverted, and a lateral anastomosis was then made between the ileum and ascending colon; drains of gauze wrapped in rubber tissue were placed in the pelvis and wound closed to drains.

Patient returned to bed in fair condition, somewhat shocked. Normal salt solution fifty-five cubic centimetres given subcutaneously, and by Murphy rectal drip, glucose and bicarbonate of soda administered. Uncomplicated convalescence followed and at the end of three weeks he left the hospital for home, wound healed.

February 9, 1928, patient states he is fully well and has been so since operation.

<div style="text-align: right;">

Francis Joseph Kirby, M.D.,
*Baltimore, Md.*

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# BOOK REVIEWS

A Text-book of Surgical Diagnosis. Edited by A. J. Walton. In two volumes. Octavo, leatheroid; pp. 534 and 587. Wm. Wood and Co., New York, 1928.

This is a very convenient handbook, owing to its division into two moderate sized volumes, in a form that is easy to handle and consult. It is an interesting example of the present-day tendency to teamwork in writing as well as in practice. This book is the result of the coöperation of thirty-one different authors, each of whom is to be accepted as of established reputation in his special branch of surgery. Such may well be the case for they are drafted for this work from prominent British Hospitals, in fact from seventeen different ones in which are represented not only London but also Birmingham, Manchester, Leeds and Edinburgh. From London itself we recognize the London, Guys, Westminster, Kings College, Middlesex, St. Marks and West London Hospitals. As Mr. Walton, the editor of the combined product, is a London Hospital surgeon, it would be natural that the staff of his hospital should be especially well represented in the list of his co-workers. Such is indeed the case, for of the fifty-two chapters presented by the two volumes, twenty are the work of the staff of that great institution. Seven of these are by Mr. Walton himself. There is one chapter by an American surgeon. We are not surprised to find that when search was being made for an adept in the diagnosis of so complicated and important a subject as Acute Infections of the Hand our confrére of Chicago, Allen B. Kanavel, was chosen. This is a choice the propriety of which American surgeons can understand. It cannot fail to create a good impression among us for the rest of the collaborators. The editor-in-chief says in his preface that there has been a tendency for the knowledge and practice of operative treatment to outstep that of surgical diagnosis. He, therefore, has been prompted to produce a book which in a special degree should deal with the difficulties of diagnosis of surgical lesions in a concise and practical manner. The result of his efforts is this book. It has evidently been thoughtfully planned and well executed. The ideas and methods of men specially skilled in their several departments have been elicited and are here presented. No one will go astray who follows the counsels here contained. It is to be noted as a feature of the book worthy of special commendation that while modern laboratory methods of investigation are given due weight and proper importance, the value and importance of the clinical history and the physical examination of the patient are still emphasized, and their place insisted upon as of prime importance among methods of diagnosis to which other methods should be regarded merely as accessory.

Lewis S. Pilcher.

UROLOGICAL RÖNTGENOLOGY. By HUGH A. YOUNG, M.D., and CHARLES A. WATERS, M.D. 4to., cloth, pages 496. Paul B. Hoeber, New York, 1928.

This book forms the seventh volume of the "Annals of Röntgenology" as edited by James T. Case, M.D. There is no subject in diagnosis in which the X-ray plays such an important part as that of urology, and indeed none in which it is more difficult to evaluate the film findings correctly. This is correctible to a large extent by the experience of the röntgenologist who interprets the films; but, irrespective of the reader's experience, to have for consultation such an atlas of master röntgenograms as this volume affords must prove of importance.

In no field of diagnosis or therapeutic endeavor have more rapid and important strides been made than in the conjoint work of the röntgenologist and the urologist. Primarily the elaboration of the combined cystoscopic-Röntgen-ray table greatly improved the possibilities of this conjoint work, and the introduction of the Bucky diaphragm similarly enhanced the degree of accuracy and more definite delineation of the organs and viscera involved.

The authors, appreciating the importance of the intimate knowledge of each other's problems, have apparently felt it necessary to include a brief but comprehensive outline of the whole subject of urology, rather than simply a röntgenological atlas of the genito-urinary tract, stressing the pathology and gross and minute changes externally and internally which they produce, and also a brief outline of the symptomatology, diagnosis, and therapy of the various conditions considered and depicted. In many instances case histories are succinctly recorded. An interesting and convenient departure is the inclusion of a diagnostic case index whereby the illustrations and case histories are made of much greater value to both departments.

The volume contains 518 illustrations. The radiographic pictures are most excellent and extremely instructive. Emanating as it does from the Brady Institute of Johns Hopkins Hospital it naturally reflects the work done there and stamps it as a most authoritative treatise.

JAMES T. PILCHER.

UROLOGY. By EDWARD L. KEYES, M.D. 8 vo, cloth, pp. 763. D. Appleton & Co., New York, 1928.

The most concise critical statement which can be made concerning this book is to say that it is Keyes'. It represents the views and ideas of its author better than almost any other book that has come to the reviewer's attention. The reader will find characteristic and delightful the animated style and frequent flashes of wit and humor, and the frank use of the first personal pronoun throughout.

The book, therefore, is a free expression of the author's mind and is not highly systematized. The latter feature is compensated by an adequate index. The subject matter represents the largely clinical viewpoint of the author. In his preface he says boldly, "Let us leave pathology to the pathologist", and

he has done this. He has also substituted the fruits of a varied and extensive experience for lengthy abstracts of the literature. Procedures and opinions which he has not adopted are dismissed with a word, but, on examining carefully the subject matter, one finds there a measure of the man who writes, for it is sound and filled with common sense.

The reviewer does feel, however, that the reader should realize these characteristics of the book and that, on account of them, understand that it is not a compendium of everything that is known or taught in modern urology, but is the autographic credo of one highly talented urologist. The reviewer feels that the suitable text-book for the student or beginner should be built more on a pathological basis, but no one who has had such a basis can fail to profit from reading this book.

The sanity of the author is particularly seen in his admirable chapter on "Derangement of the Male Genital Functions". Gonorrhœa, exclusive of stricture, has fallen from its former preponderant position and is now confined to sixty-seven pages at the end of the book. This is in line with the modern trend of urology. The mooted question of ureteral stricture is treated in a conservative way which well falls in with the views of most urologists. The illustrations are good and adequate. All of the X-ray pictures have been reproduced as outline drawings, and are surprisingly satisfactory. The last chapter is made up of "maxims" concerning gonorrhœa, which are models of compactness and lay stress, as they should, on the hands and brain of the physician.

DAVID M. DAVIS.

TEXT-BOOK OF UROLOGY. By DANIEL N. EISENDRATH, M.D., and HARRY C. ROLNICK, M.D. 8 vo. Cloth. Pp. 942. J. B. Lippincott Co., Philadelphia, 1928.

This book of Doctors Eisendrath and Rolnick is in striking and interesting contrast with that of Doctor Keyes. This, of course, is as it should be. In the past our urological text-books have been too much alike.

The authors have deliberately set out to write a text-book for students. Without the extensive personal and ancestral background of Doctor Keyes, they are more eclectic, more laborious, and more systematic. For the benefit of the student, the text is beset with words and phrases in dark-face type. This is no doubt of value for quick reference, but the reviewer doubts that it will help the earnest reader. The literary style leaves something to be desired, and the English is not always above criticism.

One hundred seventy pages are devoted to a very thorough consideration of equipment and technic. This leaves 628 pages for pathological and clinical description and 114 pages for the operative manual. The indexing has been very thoroughly done. Symptoms and diagnosis are completely covered, but the reviewer would like to see more pathology. Some of the sections on treat-

ment are admirable, but others are so brief that they leave the inexperienced in doubt as to how to proceed in a given case.

At a very few points the eclecticism of the authors fails. Three examples suffice. They do not like the Kollman dilator, they think indigo-carmine will supplant phenolsulphonephthalein as a functional test for cystoscopic work, and they recommend without reservation the syringe method for pyelography. They may be quite right, but the student should be acquainted with other views on these matters. The chapter on Sexual Neuroses by Doctor Koll is orthodox. The reviewer thinks that more emphasis will have to be laid on the psychotic aspects of these disorders.

The text is very well documented, and there is no doubt that the generous provision of references to the literature is beneficial to the student. This feature deserves wide imitation. Stricture of the ureter is given a wise and sane interpretation. Doctor Eisendrath's interest in congenital anomalies, especially of the kidney and its circulation, has made these sections strikingly excellent. The illustrations are abundant and very good. They go to new lengths in utilizing the visual method for inculcating fundamentals.

The authors are to be congratulated on producing *de novo* such an excellent book. It is a mine of information.

<div align="right">DAVID M. DAVIS.</div>

## PULMONARY INFARCTION AND EMBOLISM *

### By Charles E. Farr, M.D.

AND

### Rose Spiegel, M.D.

#### OF NEW YORK, N. Y.

A CLINICAL AND STATISTICAL STUDY FROM THE FIRST SURGICAL DIVISION (CORNELL) OF THE NEW YORK HOSPITAL

THE border line between the normal and abnormal grouping of the cellular elements of the blood is ill defined. The mechanical factors of stasis and trauma, however slight in degree, whether accidental or due to surgery, must inevitably lead to thrombosis and probably, in many instances, to embolism and minor degrees of infarction. Only the grosser manifestations give clinical evidences and are at times recognized as such. Chemical alterations of blood serum and tissue juices, of which we know very little, must be extremely frequent and unquestionably are important elements in thrombosis.

In this paper, a large series of case histories, both medical and surgical, and covering a wide range of injuries and diseases, were studied with a view to finding evidences of thrombosis, embolism and infarction. The autopsy records have been compared with the clinical data. Tentative conclusions have been drawn, but the subject is as yet far too obscure for exact deductions.

*Method of Study.*—The records of the First Division of the New York Hospital have been culled for items of value in this problem. Pulmonary embolism, generally recognized as a surgical complication, has been considered from the medical point of view as well. Its medical incidence has been investigated also in those diseases in which it might occur as an unidentified complication: typhoid fever, chronic cardiac valvular disease, lobar pneumonia, tuberculosis, and leukemia. We are very grateful for the coöperation of the First Medical Division in this matter and especially for the interest of Dr. Lewis A. Conner, its chief.

The study includes cases extending back to 1881. As would be expected, their distribution becomes more sparse as the period under consideration becomes more remote. A detailed statistical study, as presented in the tables, extends from 1917 to 1927, during which interval there has been improvement in the case records. This period of ten years is adequate as a basis for statistical deductions.

The errors in this study depend on the impossibility of evaluating the personal equation entering into observation and technic—clinical and pathological. The diagnosis arrived at by autopsy has been taken as exact, and it is obvious how important is the individual interest of the pathologist in

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\* Read before the New York Surgical Society, November 28, 1928.

finding the thrombus or embolus. Other criteria used are the röntgenological and the clinical diagnosis, and, finally, the description of symptoms which were otherwise designated, but which are more appropriately considered under pulmonary embolism and closely related phenomena. To this end, the complications, bronchopneumonia, lobar pneumonia, and pleurisy, have been investigated.

Pathology.—Pulmonary embolism, in this study, has been considered the metastasis of suspended abnormal elements in the blood, via the right heart, to the lesser circulation, with the resultant effects due to impaction in a pulmonary artery.

This definition includes in its scope a wide range of diverse clinical and etiological phenomena. Of the various embolic possibilities, we shall limit our discussion to thrombi on the venous side of the circulation, including the right heart.

Thrombi vary greatly in mode of formation, characteristics, and clinical significance. A non-friable, or organized, thrombus is not very dangerous, though it may cause inconvenient local occlusive symptoms. Usually, only the disastrous concomitants of thrombosis are considered; but the conservative value of the process should be remembered. The surgeon who dreads post-operative femoral or iliac thrombosis also dreads the alternative of absence of thrombosis—uncontrollable bleeding. Thrombosis in small blood vessels about a site of inflammation is a barrier against dissemination of the infection. Thrombosis of the prostatic and pampiniform plexuses is almost physiological in old age. These are truisms of pathology.

Since thrombosis is the usual event in infection and following surgical procedures, and is frequent in the elderly, why are not embolic phenomena more common? Essentially, the explanation seems to lie in those factors governing the organization and friability of thrombi.

The following is the classical summary of the etiology of thrombi,[1] without which consideration of embolism and thrombosis is not complete: (1) Changes in the blood plasma and formed elements; (2) Changes in the blood stream—rate of flow and vortices; (3) Changes in the vessel wall.

Changes in the Blood.—Coagulation thrombi depend on the release of fibrin by interaction of fibrinogen, prothrombin, and calcium salts in the plasma with thrombokinase from injured leucocytes, blood platelets, or tissue cells. Also, following repeated hæmorrhage, there is increased coagulability. The detritus of red blood cells resulting from hæmolysis serves as a focus of origin for a thrombus.

Obviously, trauma predisposes to thrombosis by the release of thrombokinase from the injured tissue cells.

Agglutination thrombi form by the increased agglutinative properties of red blood cells, as in typhoid fever. (In typhoid fever, our studies and Dr. L. A. Conner's[2] on thrombophlebitis indicate a closer relationship between thrombosis and phlebitis than between thrombosis and agglutination.)

Changes in the Blood Stream.—Stagnation thrombi form because of local stasis above venous valves, in varices, and aneurisms, and in the cardiac

chambers. These thrombi are apt to be of mixed type and resemble post-mortem clots. Stasis alone is not sufficient to cause thrombosis, as Baumgarten's experiments have shown that careful ligation of vessels is not followed by thrombosis, and Welch[3] found that even coarse ligation is not invariably followed by thrombosis. The other factors are apparently more important.

In the formation of marantic thrombi, besides stagnation, the changed composition of the blood and the underlying toxic factors are causative. Only unusually are the very large veins primary seats of marantic thrombi.

The importance of vortices was emphasized by von Recklinghausen. There is an "eddying movement of the outer lines of flow of the blood stream when there are counter currents, or when the blood with retarded flow passes from smaller into larger channels or over obstructions, or especially into spaces relatively too wide for the received volume of fluid." Such irregularities occur in the dilatations just above the insertion of the venous valves and in the femoral vein near Poupart's ligament, which, because of fixation to fascia, cannot adjust itself to a changed volume of blood.

*Changes in Vessel Wall.*—According to the accepted theories of thrombosis and coagulation, the normal intimal cells secrete an antithrombin. When injured, their inhibitory product is diminished and thrombokinase is released. Be that as it may, phlebitis almost invariably is accompanied by thrombosis. Which is the prior process is undetermined, for simple degenerative changes in the endothelium, and arteritis, with lesions analogous to phlebitis, seldom are accompanied by thrombosis in the general circulation. In arteritis, the force of the blood current is preventive.

In some cases of typhoidal "phlebitis" where it has not been possible to demonstrate the infective organism locally, a subendothelial collection of lymphoid tissue has been found, which may have initiated the thrombosis.

Thrombosis at the site of phlebitis is conservative by keeping the products of inflammation and degeneration from entering the blood stream.

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The changes directly involving the thrombus influence its probable embolism. Besides autolytic degeneration by the leucocytes in the thrombus, and fatty degeneration, the degree and kind of inflammatory reaction of the intimal cells are important. Minimal proliferative action, as in marantic thrombosis, so that the thrombus is loosely attached, and a predominatingly suppurative process in the vessel wall, so that the thrombus disintegrates, are most likely to release a train of embolic phenomena. Cicatrization by the intimal cells, or canalization by central softening and peripheral organization, is most favorable.

The site of thrombosis also influences embolism, as has been indicated in the discussion of vortices. The hyaline thrombi in the pulmonary capillaries in lobar pneumonia are not likely to be dislodged, nor is a thrombus in a small vein which is not subjected to much force from the blood current.

In a larger vein, a beginning thrombus, consisting only of a framework of platelets and leucocytes, is conceivably readily fragmented, particularly by

the changing pressure due to venous pulsations. A constantly fragmenting thrombus could be responsible for pneumonic symptoms in the early part of the post-operative course and might presage the dislodging of a large portion when thrombosis had proceeded to the stage of addition of the cohesive fibrin. According to Welch, cicatrization of a thrombus requires about a week. A thrombus is particularly menacing, when, by accretion of proximal coagulated stagnant blood, it juts into a larger lumen at the point of junction of a tributary, the force of whose blood stream breaks off the projecting part.

Aschoff has pointed out, that, besides the proximal part of the femoral vein where large valves are present, the pelvic plexus is a favorite site. He emphasizes the importance of continued excessive pressure on the wall of a vein—as in the veins of the legs when the body is upright, and on the pelvic plexus by the downward pressure of intestines. When the body is prone—a position negligible in most major surgery—the femoral veins are compressed against Poupart's ligament. In the supine position—which is more important —there is compression of the left iliac vein by the right iliac, middle sacral, and left hypogastric arteries. However, in abdominal surgery, thrombosis most frequently originates in the left femoral vein.

Thrombosis has been attributed to the action of bacteria. Do the bacteria settle in an already formed thrombus? Do they cause changes in the intima primarily which are then followed by thrombosis? This is the problem in thrombophlebitis and also in marantic thrombi. In the latter, special technic has frequently demonstrated the presence of microörganisms. Recently, Rosenow [4] isolated a diplostreptococcus of low virulence from post-operative thrombi with evidence that it is causative of thrombosis. Often the bacteria found in the thrombus are not those of the original disease. What is the train of events here?

In the surgical cases, the introduction of aseptic technic has apparently not been followed by a proportional diminution in the number of cases of post-operative pulmonary embolism.

Thrombosis may occur at a site distant from the infected operative field, as in an appendectomy, complicated by fatal pulmonary embolism, with the thrombosis limited to the larger veins of the left side. On the basis of a theory of infection, it is difficult to account for localization of infective material from the blood vessels of the appendiceal area—portal circulation—in the general caval circulation.

The emphasis on the etiology of thrombosis has been shifted to mechanical conditions during and after the operation. Stasis due to the position during operation has been cited; however, the femoral vein is not compressed and the downward pressure of the intestines is diminished in the supine position. There is far more strain and circulatory embarrassment in the erect position.

The onus has been laid at the door of surgical technic. In a ten-year period, of 12,813 operations performed under blunt dissection, there were twenty-two fatal cases of pulmonary embolism, or .171 per cent., against a parallel period with 12,615 operations under fine dissection with twenty-one

fatal cases, or .167 per cent.; this discrepancy of about 2 per cent. is within the permissible range of statistical error. Compression of blood vessels, defective ligation, unnecessary traumatization of tissues are, perforce, poor surgical technic from any point of view, and presumably do not occur in this service.

The pre-operative preparation of the patient has also been attacked, with particular emphasis on the elimination of foci of infection. However, this is obviously an unattainable ideal. In emergencies, for instance, it is out of the question.

Increase of body fluids is the most practicable procedure suggested, but obviously does not strike at the root of the matter.

The theory that the post-operative pneumonitides have an embolic basis has been gaining ground. Respiratory affections form the greatest single group of complications, besides wound infections, attributable to the operation. The following table shows the partition of complications:

*July, 1914–1927*

| Total Post-operative Complications | Respiratory Complications | | | | | | |
|---|---|---|---|---|---|---|---|
| | Abscess of lung | Lobar pneumonia | Broncho pneumonia | Acute bronchitis | Pleurisy | Pulmonary infarction | Pulmonary embolism |
| Duodenal ulcer.........  48 | – | 5 | 2 | – | 1 | – | 1 |
| Gastric ulcer...........  18 | – | – | 3 | – | – | – | 1 |
| Acute cholecystitis.......  5 | – | – | 1 | – | – | – | – |
| Appendicitis............342 | – | 16 | 11 | – | 2 | 8 | 6 |
| Hernia: non-strangulated.170 | 1 | 15 | 10 | 8 | 1 | 8 | 6 |
| Hernia: strangulated.....  19 | – | 2 | 2 | – | – | 1 | 1 |
| Varix of veins of leg.....  11 | – | – | – | – | – | – | 2 |

Determination of the causative factors underlying the post-operative pneumonias would alter only slightly the treatment of the so-called bronchopneumonias, lobar pneumonias, and pleurisies. The therapeutic problem thus is forced back to thrombosis.

*Analysis of Autopsied Cases of Pulmonary Embolism.*—Before entering this doubtful province of the embolic nature of early post-operative respiratory complications, we shall present an analysis of sixteen autopsied cases, fifteen of which are undoubtedly pulmonary embolism, with practically complete clinical, X-ray, and pathological data. With the deductions which we are enabled to make, we shall analyze the unautopsied material.

The cases of pulmonary embolism which come to autopsy generally present startling symptoms with immediate fatality. The following case summary is typical:

*Three days following a diagnosis of bronchopneumonia, based on physical signs and X-ray findings, the patient suffered "a grinding precordial pain, immediately followed by a convulsion. The pulse became imperceptible; the respiration slow and labored. The patient was cyanotic. Death in five minutes."*

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Whenever the relationship of circulatory to respiratory cessation has been noted on the charts, the former apparently occurred first.

The following is the incidence of this type of case in autopsy material:

*Autopsy Record of Pulmonary Embolism*

1917–1926—Total number autopsies .......................... . .. 1,116

          Total number pulmonary embolism (fatal) .............. 30

          Per cent. of total number ........ ....... ............. 2 68 per cent

| Year | Number of autopsies | Surgical cases | Medical cases | Accident | Per cent of autopsies |
|------|---------------------|----------------|---------------|----------|-----------------------|
| 1917 | 121 | 3 | I | – | 3 3 |
| 1918 | 79 | – | – | – | – |
| 1919 | 77 | – | – | I | I 28 |
| 1920 | 87 | – | – | – | – |
| 1921 | 74 | 2 | – | – | 2 7 |
| 1922 | 95 | 4 | – | – | 4 2 |
| 1923 | 119 | 7 | – | – | 5 8 |
| 1924 | 166 | 3 | I | – | 2 4 |
| 1925 | 148 | 3 | – | – | 2 03 |
| 1926 | 150 | 5 | – | – | 3 3 |

Following is a summary of the autopsied surgical cases available for our examination.

TABLE I.

*Analysis of Fifteen Autopsied Cases of Pulmonary Embolism*

CASE 1—Female, aged fifty-seven years. Suddenness of death—immediately. Operation—perineorrhaphy. Post-operative day onset—seventeenth. Previous symptoms—sixteenth post-operative—dyspnœa. Pathological report: Pulmonary artery—large thrombus, source of embolism—left femoral and three left iliac veins.

CASE 2—Female, aged forty-two years. Suddenness of death—twenty-five minutes Operation—exploratory laparotomy, appendectomy, cholecystectomy, bilateral salpingectomy. Post-operative day onset—eleventh. Previous symptoms—remittent 99°–101°. Pathological report—pulmonary artery—all branches. Source of embolism—left internal iliac vein.

CASE 3—Male, aged thirty-four years Suddenness of death—three days agony five minutes Operation—appendectomy (chronic). Post-operative day onset—fifteenth Previous symptoms—bronchopneumonia, third clinical and X-ray. Pathological report—pulmonary artery—pulmonary artery and branches. Lungs—infarcts bases. Source of embolism—right internal iliac branch; left internal veins. Miscellaneous—*B. coli* in thrombus.

CASE 4—Female, aged fifty-nine years. Suddenness of death—ten minutes Operation—radical amputation of breast Post-operative day onset—eighth Previous symptoms—remittent 98°–101°. Precipitating cause—fainted in lavatory. Pathological report—pulmonary artery—pulmonary artery and branches Source of embolism—disintegrated axillary vein.

CASE 5—Female, aged fifty-five years. Suddenness of death—two days agony, twenty minutes Operation—ventral herniotomy Post-operative day onset—seventeenth Previous symptoms—bronchopneumonia two days. Pathological report—pulmonary artery—pulmonary artery and branches Lungs—infarcts bases. Source of embolism—from internal profunda femoris into femoral vein. Miscellaneous—infected laparotomy wound.

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CASE 6.—Male, aged fifty-one years. Suddenness of death—eight hours agony, five minutes. Operation—appendectomy (gangrene free pus). Post-operative day onset—fifth. Previous symptoms—undiagnosed. Pathological report—heart—chronic myocarditis. Pulmonary artery—left pulmonary artery. Lungs—right base. Source of embolism—no examination.

CASE 7.—Male, aged thirty-four years. Suddenness of death—thirty minutes. Operation—appendectomy (chronic). Post-operative day onset—ninth. Precipitating cause—sitting up. Pathological report—heart—large thrombus right ventricle. Pulmonary artery—large at bifurcation of pulmonary artery. Source of embolism—left internal iliac vein.

CASE 8.—Male, aged forty years. Suddenness of death—five minutes. Operation—exploratory laparotomy and gall-bladder drainage. Post-operative day onset—first. Previous symptoms—on admission dyspnœa and cyanosis. Pathological report—heart—chronic myocarditis. Pulmonary artery—pulmonary artery and across bifurcation. Lungs—infarct left base. Miscellaneous—acute gastric dilatation.

CASE 9.—Male, aged forty-seven years. Suddenness of death—five minutes. Operation—fractured ribs—no operation. Post-operative day onset—second in hospital. Previous symptoms—bronchitis—103°. Pathological report—heart—dilatation right ventricle. Pulmonary artery—pulmonary artery and across bifurcation. Lungs—congested bases right areas hæmorrhage. Source of embolism—local injury.

CASE 10.—Male, aged sixty-three years. Suddenness of death—three hours. Operation—exploratory thoracotomy for subphrenic abscess. Post-operative day onset—fifteenth. Previous symptoms—fifteenth—apparent heart failure. Pathological report—pulmonary artery—both branches. Miscellaneous—suppurative cholecystectomy.

CASE 11.—Male, aged fifty-four years. Suddenness of death—seven days. Operation—repair of perforated ulcer. Post-operative day onset—thirteenth. Pathological report—heart—verrucous endocarditis. Pulmonary artery—left. Lungs—gangrene left. Source of embolism—thrombophlebitis right internal iliac vein. Miscellaneous—from peritonitis, staphylococcus, and streptococcus hæmolysis.

CASE 12.—Male, aged fifty-five years. Suddenness of death—four days agony, thirty minutes. Operation—bilateral herniotomy. Post-operative day onset—fifth to ninth. Previous symptoms—severe cough, pleural pain on fifth. Pathological report—pulmonary artery—both branches. Lungs—congested. Source of embolism—left external and internal and common iliac veins.

CASE 13.—Male, aged sixty-four years. Suddenness of death—five minutes. Operation—suprapubic cystostomy local anus. Post-operative day onset—tenth. Precipitating cause—enema. Pathological report—heart—large thrombus right ventricle. Pulmonary artery—both branches. Lungs—no change. Source of embolism—right and left internal iliac veins. Miscellaneous—from heart streptococcus non-hæmolysis.

CASE 14.—Male, aged sixty-five years. Suddenness of death—ten days. Operation—first stage—perineal prostatectomy, local anus. Post-operative day onset—twenty-seventh. Previous symptoms—lobar pneumonia X-ray—thirty-second not characteristic middle right lobe. Thirty-seventh dilatation right ventricle and super vena cava including density in right base. Pathological report—heart—dilatation right ventricle. Pulmonary artery—smaller branches. Lungs—right middle lobe congested. Source of embolism—prostatic plexus right internal iliac vein.

CASE 15.—Male, aged thirty-six years. Operation—fractured ribs and acetabulum. Post-operative day onset—third. Pathological report—pulmonary artery—main and left. Source of embolism—left internal iliac vein. Miscellaneous—pelvic tissue necrotic.

Physical examination on admission in no case revealed any cardiac or pulmonary abnormality.

The above Table I indicates the following:

1. The age range is between thirty-four and sixty-five—average fifty years.

2. Average day of onset of fatal symptoms, eleventh, limits first to twenty-seventh.

3. Partition of cases among operations: Appendectomy, 3; herniotomy, 2; exploratory laparotomy, 2; prostatectomy, 2; perineorrhaphy, 1. This distribution is inconclusive.

4. Relation of site of thrombosis to operative field:

(1) Perineorraphy: Left femoral vein; internal iliac; external iliac; left common iliac.

(2) Exploratory laparotomy: Bilateral salpingectomy; cholecystectomy; appendectomy; plication of round ligaments; lipectomy; left internal iliac vein.

(3) Appendectomy: Left internal iliac vein—small branches; right internal iliac vein—up to right common iliac.

(4) Radical amputation—right breast: Right axillary vein—disintegrated.

(5) Repair of ventral hernia: Left profunda femoris vein and projection into femoral vein.

(6) (No examination.)

(7) Appendectomy: Left internal iliac vein.

(8) (No examination.)

(9) Exploratory laparotomy: Origin not found.

(10) Fractured right ribs: Local injuries—partial collapse of lung.

(11) Thoracotomy: Origin not found—no phlebitis.

(12) Repair of perforated duodenal ulcer: Thrombophlebitis right internal iliac vein.

(13) Repair of bilateral hernia: Left internal, external, and common iliac veins.

(14) Prostatectomy, first stage: Both internal iliac veins.

(15) Prostatectomy: Prostatic plexus, right internal iliac vein.

(16) Fractured acetabulum and ischial spines; fractured ribs; dislocation of hip: Left internal iliac vein and branches (necrotic pelvic tissue).

(17) Suprapubic cystostomy: Septicemic infarction.

5. Frequently warning pulmonary signs and symptoms are present, though the final death agony is brief; of the fifteen cases seven lasted more than an hour; in five, it was a matter of days.

6. Four cases were septic—Nos. 2, 4, 5, 11. In all but No. 2, symptoms lasted several days.

7. Clinical diagnosis of pulmonary embolism in its prodromal stage is frequently erroneous, or, perhaps more accurately stated, is misleading in terminology.

8. X-ray findings of a newly-lodged embolus, or a newly-formed infarct, are misleading, principally because of the desire of the clinician to receive a positive, clear-cut statement. Obviously, the anatomical changes following a process of one or two days, or occasionally several hours' duration, cannot be

more than suggestive. In case No. 3, "left bronchopneumonia" was found at autopsy, two days later, to be a typical wedge-shaped infarct in left lower lobe.

9. The type of anæsthesia is apparently of no significance. Case Nos. 13 and 14, two elderly men with enlarged prostates, who were in very good condition on admission, were operated on under regional anæsthesia.

10. The importance of pulmonary embolism as cause of sudden death is variable.

1. CASE No. 8, on admission, had the same symptoms which were present at death; severe dyspnœa and cyanosis. The infarct in the left lower lobe was inadequate as a cause of death from cardiac embarrassment and from encroachment on the margin of safety of lung tissue. The chronic myocarditis and the acute gastric dilatation were probably the lethal factors.

2. CASE No. 11. Details of the history indicate that on the first day of symptoms patient suffered an attack of pulmonary embolism; "sudden, terrific pain in right chest with immediate collapse, coughed up bloody sputum and had moist râles and impaired resonance over right base. Three days later, friction rub in left axilla, and bronchial breathing in left base. Several days later coughed up black, foul, purulent sputum." Autopsy revealed pulmonary gangrene of left upper lobe, secondary to an infected embolus from the thrombophlebitic right internal iliac vein, as the most probable cause of death.

3. CASE Nos. 2, 4, 5, 12. When the pulmonary artery or its first subdivisions are occluded by an embolus, profound shock and rapidly failing circulation ensue, due, perhaps, to the sudden ischemia, or to the irritation of the efferent nerves of the vessel wall by the changed circulatory conditions. In no case do we know how much of the occluding mass is the original embolus, nor about how much time was required for the surrounding thrombus to form. A small embolus may block a minor artery and part of the column of blood toward the heart, thrombosed because of stasis. The original embolus may be responsible for prodromal symptoms culminating, several hours later perhaps, in the terminal agony when a major branch, or the pulmonary artery itself, becomes occluded. The problem is to correlate the clinical and pathological sequence.

4. A large thrombus of embolic origin in the right ventricle may interfere with the flow of blood enough to cause death. Case Nos. 7 and 13. Death occurred before there was any tissue reaction to the emboli lodged in the branches of the pulmonary artery, so that the sudden death may be attributed to right heart failure.

5. The disturbed circulation may embarrass a heart with chronic myocarditis, and dilatation of the right ventricle occur. Case Nos. 8, 10, 14, 15—in at least six of the cases, therefore, cardiac involvement was a factor in producing death. Particular care of the surgical patient with myocardial disease is, therefore, indicated.

11. In regard to diagnosis, there were several illuminating errors.

A female, thirty years of age, whose chief complaint was epigastric pain and whose physical examination was absolutely negative, was operated upon for probable cholelithiasis and chronic appendicitis. No pathological condition adequate to account for the symptoms was found. On the second post-operative day, while talking to a neighbor, the patient "stopped, made a little sound, and became unconscious. Pulse imperceptible. Died in a few minutes." Death was attributed to pulmonary embolism. The only significant finding at post-mortem examination was a stenosed right coronary artery and luetic aorta. The record of this case, besides indicating that the entire clinical picture was due to coronary sclerosis, demonstrates that death due to pulmonary embolism has some clinical features in common with sudden cardiac death. Similarly in the following case: Man of eighty-five years, with chronic bronchitis and myocarditis. At autopsy, a staphylococcus aureus lobar pneumonia and coronary sclerosis were found, which were the probable causes of death.

12. The precipitating cause frequently is unassignable and practically always is undetermined.

CASE No. 7.—It does not seem, when matters are in such a precarious state, that sitting up in bed is sufficient to start a thrombus on its embolic career, that immobilization would stave off the evil day. It may very well be that the restlessness was merely symptomatic rather than causative. In looking for a precipitating cause, the tendency is to use the *post hoc, ergo propter hoc* principle.

CASE No. 13.—Death occurred during the administration of an enema. The frankly ante-mortem thrombus found in the heart dates the lodging of the embolus at least twenty-four hours before death; therefore, the enema could not have precipitated the embolism.

13. Clinically none of these cases manifested any evidence of venous thrombosis, extensive as was the process in most cases. (This may be explained on the following basis: The large deep veins draining the lower extremities have an adequate collateral circulation, while the smaller and more superficial have not. Occlusion of the latter, therefore, more frequently causes signs.)

14. Case No. 12 suffered two attacks of pulmonary embolism on the fifth and ninth post-operative days.

*Analysis of Unautopsied Cases of Pulmonary Embolism.*—In this series of twenty cases diagnosed clinically, we consider only those in which there is an episode of sudden collapse, dyspnœa, and pleural pain during convalescence. The milder cases, lacking the symptom-complex of collapse, are considered under the heading "Pulmonary Infarction." In some instances, it is difficult to determine from the case records how severe the onset was. Some of the cases are on the border line, part of them has been included in this group, and others in Pulmonary Infarction; so that the error has been equally distributed.

In the decade 1917–1926, there were thirteen autopsied cases, nine unautopsied deaths, and seven recoveries, the chances for recovery thus being twenty-five per cent., to place the emphasis optimistically. The following case summary (Table II) includes all the records we have been able to obtain beyond the above decade, as well.

TABLE II.

*Analysis of Twenty Unautopsied Cases of Pulmonary Embolism.*

CASE 1.—Female, aged twenty-eight years. Operation—supravaginal hysterectomy. Post-operative day onset—seventh. Previous symptoms—convalescence good; slight distention. Symptoms of pulmonary embolism—in normal sleep: groaned, restless. Pulse: weak, gasping, pale, cyanotic. Result—died.

CASE 2.—Female, aged thirty-five years. Operation—appendectomy and freeing of adhesions. Post-operative day onset—eighth. Symptoms of pulmonary embolism—sudden pain right chest, marked dyspnœa, bloody sputum. Result—lived.

CASE 3.—Male, aged forty-six years. Operation—appendectomy (chronic). Post-operative day onset—eleventh. Previous symptoms—pain in right back—râles. Thirteenth day post-operative—symptoms of pulmonary embolism—expired suddenly. Result—died.

CASE 4.—Male, aged twenty-nine years. Operation—herniotomy. Post-operative day onset—fourth. Previous symptoms—sudden pain in left chest and slight consolidation. No pleural rub; X-ray hazy shadow in left. Fifteenth day post-operative. Symptoms of pulmonary embolism—similarly in right chest; X-ray—consolidation left base and right hilum. Result—lived.

CASE 5.—Female, aged thirty-two years. Operation—appendectomy (gangrenous). Post-operative day onset—tenth. Previous symptoms—sudden pain right base; bloody sputum—pleural rub. Precipitating cause—getting out of bed. Post-operative day onset—fourteenth. Symptoms of pulmonary embolism—similarly in right chest. Result—lived.

CASE 6.—Male, aged thirty-two years. Operation—appendectomy. Post-operative day of onset—thirteenth. Symptoms of pulmonary embolism—collapse; pain in chest. Labored respiration. Result—died.

CASE 7.—Male, aged twenty-two years. Operation—division of Harris band. Post-operative day of onset—fourth. Previous symptoms—mushy first sound and apical systolic murmur. Symptoms of pulmonary embolism—pain left chest. Some collapse. Result—lived.

CASE 8.—Female, aged forty-nine years. Operation—excision of varix (in saphenous ring). Post-operative day of onset—eleventh. Symptoms of pulmonary embolism—sudden collapse. Result—died.

CASE 9.—Female, aged twenty-nine years. Operation—appendectomy. Previous symptoms—phlebitis of left saphenous vein; cellulitis. Symptoms of pulmonary embolism—pain left chest; bloody sputum; slight collapse. Result—lived.

CASE 10.—Female, aged forty-two years. Operation—appendectomy. Post-operative day of onset—eighth. Symptoms of pulmonary embolism—pain in chest. Result—lived.

CASE 11.—Female, aged fifty-seven years. Operation—cholecystectomy. Post-operative day of onset—ninth. Symptoms of pulmonary embolism—pain left chest; cough; slight collapse. Result—lived.

CASE 12.—Female, aged forty-three years. Operation—hysterectomy. Post-operative day of onset—eighth. Previous symptoms—varicose veins legs on admission. Symptoms of pulmonary embolism—pain, cyanosis, collapse. Result—died.

CASE 13.—Female, aged thirty-eight years. Operation—hysterectomy. Post-operative day of onset—sixth. Previous symptoms—98°-100° fluctuations. Symptoms of pulmonary embolism—sudden dyspnœa and thoracic pain; nausea; loss of sight and hearing. Result—died.

CASE 14.—Female, aged twenty-five years. Operation—salpingectomy. Post-operative day of onset—twelfth. Previous symptoms—X-ray positive on twenty-fourth post-operative day. Symptoms of pulmonary embolism—pain in right chest; 104°. Result—lived.

CASE 15.—Male, aged forty-one years. Operation—laparotomy (liver abscess). Post-operative day of onset—ninth. Symptoms of pulmonary embolism—dyspnœa; collapse. Result—died.

CASE 16.—Female, aged fifty years. Operation—repair of umbilical hernia. Post-operative day of onset—fifth. Previous symptoms—Pain right chest; slight signs of consolidation in right axilla; bloody sputum. Eleventh day post-operative—symptoms of pulmonary embolism—sudden collapse. Result—died.

CASE 17.—Female, aged fifty-five years. Operation—drainage of pelvic abscess. Regional anæsthetic. Post-operative day of onset—second. Previous symptoms—post-operative vomiting. Symptoms of pulmonary embolism—convulsions; pulse 100. Respiration; fall in blood pressure; coma. Result—Died.

CASE 18.—Female, aged forty-seven years. Operation—drainage of gall-bladder. Post-operative day of onset—tenth. Previous symptoms—Severe saphenous phlebitis (varicose veins on admission), convulsive attack. Symptoms of pulmonary embolism—(assoc. chronic myocarditis). Fourteenth day post-operative—Symptoms of pulmonary embolism—dyspnœa, cyanosis, vertigo, apprehension, collapse. Result—died.

CASE 19.—Male, aged thirty-eight years. Operation—gastro-enterostomy. Post-operative day of onset—first. Previous symptoms—pain in chest, 103°. Second day post-operative—symptoms of pulmonary embolism—106°; cough; pain; collapse. Result—died.

CASE 20.—Female, aged forty-two years. Operation—herniotomy. Post-operative day of onset—eighth. Previous symptoms—post-operative acetonuria. Symptoms of pulmonary embolism—sudden pain right chest; cyanosis; faint. Result—lived.

    1. Age range—twenty-two to fifty-five years; average—thirty-nine years.
        Average age in fatal cases ........................forty-two years.
        Average age in recoveries ........................thirty-five years.

In comparing these figures with similar ones from the autopsied cases, one is struck by the definitely younger age group above and with the younger group in the recoveries.

2. Average day of onset—seventh post-operative (frank symptoms of pulmonary embolism). Six out of twenty occurred in the first week. Note the earlier time of onset in this series.

3. Five cases (Nos. 3, 4, 5, 16, 19) apparently suffered more than one attack—three deaths; recoveries were in the youngest individuals. In Case Nos. 4 and 16, physical examination at the time of onset of pleural pain revealed slight signs of consolidation and no pleural rub. The pathological process must have antedated the symptom of pain. We are accustomed to thinking that the pain is practically simultaneous with the embolic impaction.

4. CASE No. 18.—This case with definite cardiac involvement had an ample opportunity for the development of pulmonary embolism.

5. One recovered case and one fatal case had saphenous phlebitis, Case Nos. 9 and 18.

6. Of conditions predisposing to pulmonary embolism:
    Two—cardiac involvement—Case Nos. 7 and 18 which were fatal.
    Two—varicose veins—Case Nos. 8 and 12 both were fatal.

7. Partition among operations: Appendectomy, 6; gynæcological operations, 5; cholecystectomy, 2; hernial repairs, 2.

8. The following case summary we believe to be another instance illustrating some of the diagnostic pitfalls:

Male, fifty-five years of age, with a strangulated left indirect inguinal hernia, of negative physical examination, but for the local condition was operated on under local anæsthesia. The mesentery of the colon showed some thrombosed vessels, but seemed viable. On the morning of the third post-operative day there was sudden collapse, the temperature rose from 101° to 103°. The patient suffered a chill and became cyanotic. He had severe cramp-like abdominal pains. He recovered from the collapse to suffer a fatal one at 6 P.M. During the post-operative course, the pulse gradually increased from 70 to 140 and the respiration from 28 to 48, but no physical signs to account for this had been noted, apparently. Death was attributed to pulmonary embolism. The circumstances indicate death due to mesenteric thrombosis as more probable. Here, the common factor of collapse was the source of confusion.

**Pulmonary Infarction.**—Pulmonary infarction, roughly speaking, is characterized by some of the following symptoms and physical signs: Pleural pain, mild distress, discomfort in breathing, cough, frothy sputum with an admixture of bright or clotted blood, sharp rise in temperature, friction rub, small area of slight consolidation, slightly diminished resonance, harsh or bronchial breathing, fine râles.

This syndrome requires a different emphasis on its etiological factors from the two types already discussed. Here we must consider abnormal local conditions in the lung, the effect of the ether anæsthesia, the infectivity of the thrombus, as well as the mechanical effect of the impaction of the embolus.

# PULMONARY INFARCTION AND EMBOLISM

The collateral circulation of pulmonary, pleural, and bronchial vessels normally is adequate to compensate for any obstruction in a minor pulmonary artery. Arterial anæmia in the area of distribution causes collateral hyperæmia of adjacent arteries followed by immediate hyperæmia of the site and then by equalization. However, if the part already is in a condition of venous engorgement and high pressure, the collateral hyperæmia increases the pressure, the capillaries dilate to maximum, and diapedesis of red cells occurs. Thus, obviously, any factors contributing to cardiac embarrassment, for instance emphysema, are important at operation. The degree to which ether increases pulmonary secretion must be considered a factor in increased intrapulmonary pressure, predisposing to infarction.

Given this underlying condition, the manifestation may be pyæmic—a septic pneumonia, abscess, or gangrene. Bland infarcts are accompanied very frequently by some pleural effusion, which may be due to maladjustment of the blood supply, or to a reactive pneumonia and surrounding localized œdema. Rarely, the infarct may be anæmic, if the circulation is very poor.

The above pathological summary is the rationale for considering that the post-operative pneumonitides and pleurisies have an embolic basis, coupled with the fact that thrombosis is frequent post-operatively.

We append fifteen case summaries of post-operative pulmonary infarction as typical of the uniformity and variation in the findings. This does not include our entire array of cases which we shall summarize very briefly elsewhere.

    1. In this table (III)—average age—thirty-two years. Age range—fifteen to forty-nine years.

    2. Average day of onset of frank signs post-operatively—seventh. Nine out of fifteen in the first week.

    3. One death—Case No. 12.

    4. Phlebitis—Case Nos. 6, 8, 9. No fatalities.

TABLE III.

*Analysis of Fifteen Cases of Post-operative Pulmonary Infarction.*

CASE 1.—Male, aged forty-nine years. Operation—appendectomy gangrenous—local peritonitis. Post-operative day of onset—eleventh. Symptoms of infarction—severe pain in right lower chest; slight fever.

CASE 2.—Male, aged forty-five years. Operation—herniotomy. Post-operative day of onset—tenth. X-ray—opacity left middle chest. Symptoms of infarction—rheumatic pain in left shoulder; following day—bloody sputum.

CASE 3.—Male, aged sixteen years. Operation—appendectomy. Post-operative day of onset—fifth. X-ray—congestion of right upper lobe. Symptoms of infarction—sudden— 106°; no symptoms; slight consolidation upper right chest.

CASE 4.—Female, aged forty-five years. Operation—excision of varicose veins of right leg. Post-operative day of onset—tenth. Symptoms of infarction—pain in right chest; sore throat; cough and pain in left chest.

CASE 5.—Male, aged fifteen years. Operation—tonsillectomy. Post-operative day of onset—twenty-first. Symptoms of infarction—awakened by sharp pain in chest; increased by respiration; dyspnœa. Examination negative. Eleven days after admission fluid posterior left base. Gram-positive cocci.

CASE 6.—Male, aged thirty years. Operation—bilateral herniotomy. Post-operative day of onset—seventh. Symptoms of infarction—pain in chest, cough, fever; slight hemoptysis; consolidation right lung; coarse râles; ten days post-operative a thrombosis in left leg.

CASE 7.—Female, aged twenty-eight years. Operation—myomectomy appendectomy. Post-operative day of onset—twelfth. Symptoms of infarction—pain in right chest; dyspnœa, apprehension; posterior right base consolidation.

CASE 8.—Female, aged forty years. Operation—Billroth No. 1. Post-operative day of onset—twelfth. Previous symptoms—sixth, seventh, ninth, eleventh days unexplained rises in temperature. Symptoms of infarction—seventh day pain in right lower chest and in right knee. Twelfth day bloody sputum.

CASE 9.—Male, aged forty-three years. Operation—appendectomy (peritoneal abscess). Post-operative day of onset—sixth. Symptoms of infarction—pleural rub and pain in left chest. Bronchopneumonia twelfth day, phlebitis right calf. Post-operative day of onset—fourteenth. Symptoms of infarction—pleural rub and pain in right chest.

CASE 10.—Male, aged twenty-eight years. Operation—herniotomy bilateral (acutely inflamed asymptomatic appendix). Post-operative day of onset—second. Symptoms of infarction—104°—consolidation right posterior base; coarse râles; residual râles; sputum positive tuberculosis.

CASE 11.—Male, aged twenty-eight years. Operation—herniotomy right. Post-operative day of onset—third. Previous symptoms—(on admission rhonchi.) Symptoms of infarction—pain in chest; cough; two days later blood tinged, watery sputum; some râles everywhere; increased temperature.

CASE 12.—Male, aged twenty-three years. Operation—herniotomy right. Post-operative day of onset—first. X-ray—resembles new growth. Symptoms of infarction—septic temperature until death sixty-ninth post-operative day; pain and consolidation right chest; puncture; sterile necrotic crumbly material; boils. Signs persisted until death.

CASE 13.—Male, aged twenty years. Operation—herniotomy bilateral. Post-operative day of onset—second. Symptoms of infarction—104°. Left base posterior—consolidation; fine râles; bloody sputum; cough. Next day—dulness; vesicular breathing; temperature normal.

CASE 14.—Male, aged thirty-nine years. Operation—appendectomy. Post-operative day of onset—third. X-ray—fluid right chest. Symptoms of infarction—104°. Pain in right base posterior; impaired resonance and breath sounds; fourteenth post-operative day fluid signs right base.

CASE 15.—Male, aged twenty-eight years. Operation—appendectomy. Post-operative day of onset—first. X-ray—pneumonia left base. Symptoms of infarction—cough, flushed face; dyspnœa—103°; left lower lobe—consolidation.

The noteworthy points are the younger age group, the earlier onset of pulmonary symptoms, the higher incidence of phlebitis, and the lower mortality, as compared to the last series discussed. Perhaps this may be explained as follows: Thrombosis, excited in an unknown manner, does not proceed far, because of the better general circulation in these younger individuals. Bits of the thrombus are washed away and are responsible for the pulmonary symptoms. The force of the circulation prevents the formation of large, more disastrous thrombi. This is purely speculative.

Our series of cases of pulmonary infarction includes ten which were salvaged from other classifications. They present a sufficient number of the characteristic symptoms and signs of pulmonary infarction to come under this heading. It is safe to assume that, had observations been recorded more fully in other cases, more would have come in this category.

*Influence of Ether.*—As has already been stated, ether anæsthesia may predispose to pulmonary infarction. We have tried to evaluate this factor.
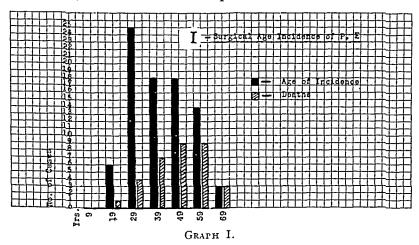
In seventeen of sixty-nine cases, the duration of ether anæsthesia was one hour or over. Obviously, more extensive surgery was required in these cases, and this factor may have been the more predominant cause of infarction. In only five, was there moderate, or much, mucus during the anæsthesia; in no instance corresponding with any of the above seventeen.

During ether anæsthesia the blood pressure, as well as the pulse rate, is normal or increases, so that there is no general circulatory stasis. However, the pressure in the pulmonary artery is raised, and this, as well as any increased intrapulmonary pressure due to bronchorrhea, predisposes to hæmorrhagic infarction. The experimental production of pulmonary infarcts under ether in otherwise normal lungs has been negative.

No truly comparable series of major operations performed under local and under general anæsthesia is possible, because of the grave condition of the patient necessitating the regional anæsthesia. Practically, our study is unilluminating.

*General Survey of Surgical Pulmonary Embolism and Infarction.*—Total number of cases in the records of First Surgical Division are eighty-four, of which thirty-three were fatal.

The distribution according to age, of the incidence of cases and of the incidence of deaths, is shown in Graph I. This demonstrates strikingly



GRAPH I.

the earlier age involvement and the concomitant lower death rate per early decade of life, than other investigations have led us to believe.
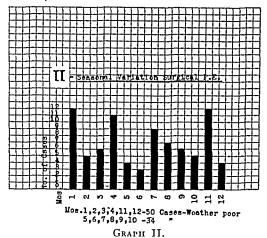
In 1909, Gibson [5] noted the comparative freedom from embolism under forty years of age and the milder train of symptoms in such cases. He also emphasized the fact that most cases occur during the first seven days—60 per cent.—and from intervention "below the belt."

The distribution according to sex—this condition is approximately twice as frequent in males, but the death rate in males is 37.3 per cent., and in females it is 42.4 per cent.
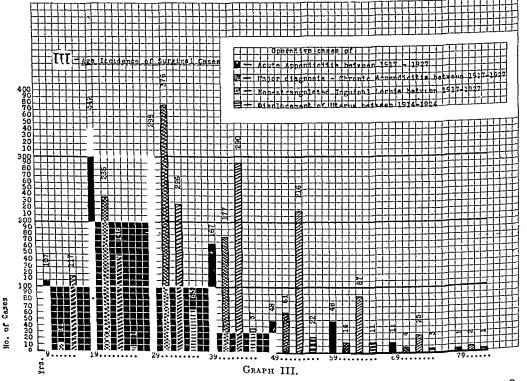
Seasonal variation—cases of pulmonary embolism predominate in the months of unstable weather. (Graph II.)

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Distribution among operations—1914 to 1927. Appendectomy: 2,962 operations, seventeen cases. Herniotomy: 1,848 operations, twelve cases. (Graph III.)

Examination was made of twenty-nine consecutive cases of prostatectomies between January and May, 1926, with a view to determining unidentified



II = Seasonal Variation Surgical P.E.

Mos.1,2,3,4,11,12-50 Cases-Weather poor
5,6,7,8,9,10 -34 "

GRAPH II.
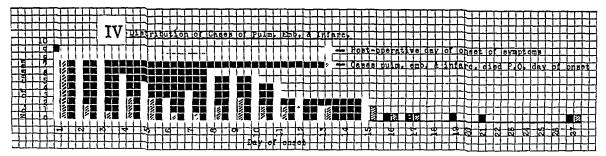
cases of pulmonary infarction and phlebitis: Three cases of phlebitis; one— (nurse's note)—none followed by pulmonary symptoms; six cases of respiratory complications: pulmonary infarction, four; pneumonia (and myocardial degeneration), one; pleurisy, one.



III = Age Incidence of Surgical Cases

Operative cases of
Acute Appendicitis between 1917 - 1927
Major diagnosis - Chronic Appendicitis between 1917-1927
Non-strangulated Inguinal Hernia between 1917-1927
Displacement of Uterus between 1914-1924

GRAPH III.

Similarly with displacement of uterus and repairs between May, 1918, and March, 1924, there were sixty-nine consecutive cases, of which two had varicose veins without pulmonary consequences.

496
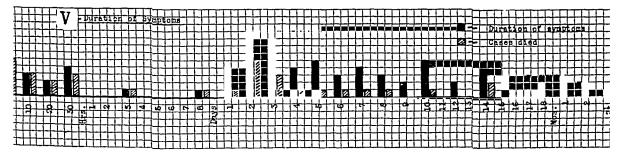
*Onset.*—Graph IV.—In this table, the onset is considered to date from the first appearance of symptoms, not necessarily of the frank pulmonary embolism and infarction. We wish to emphasize the more subtle overtures of pulmonary embolism. *The preponderance of cases in which the onset is in the*



GRAPH IV.

early post-operative course is marked. Attention has already been called to the progressively younger individuals involved with the earlier onset and more benign course.

*Duration of Symptoms.*—Graph V.—As a corollary to the recognition of the more benign pulmonary infarction is the recognition of the longer duration and the lower mortality rate accompanying these cases.



GRAPH V.

*Temperature, Pulse, and Respiration Changes in Pulmonary Embolism and Infarction.*—A temperature over 100° during convalescence has arbitrarily been considered normal.

Change in temperature is the most constant finding, though neither invariable nor uniform; pulse and respiration rates are very much increased in the few cases with immediate collapse, but, in those which recover, soon return to the previous level.

In very few of the cases with a more protracted and less disastrous course of pulmonary symptoms is a change in pulse and respiration rates recorded, though a transitory change may have passed unnoted at the time of onset.

The changes in temperature have been considered under three heads:

1. Those cases having an intermittent, septic temperature during convalescence and before the onset of the pulmonary complications (twenty-four cases);

2. Those in which the fever and onset were simultaneous (twenty-five cases);

3. Those in which there was no change or a delayed change (seventeen cases);

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(Unaccounted—fifteen cases).

*Group 1.*—An irregular, septic, intermittent temperature, 98° to 101°, or 103°. Of the fatal cases, five had definite septic conditions, local peritonitis, appendiceal abscess, subphrenic abscess, etc.

In one case there were unexplained rises in temperature for four days before the appearance of physical signs, probably due to the impaction of four successive emboli.

In the cases in which there was time for the nurses' routine, there was noted a rise in temperature simultaneous with the onset of symptoms, except in one case in which there was a gradual rise to 104°.

The physical signs, when present, and the symptoms persisted longer than the new level of temperature. Resolution by crisis, four; by lysis, six; (others unnoted).

*Group 2.*—Two cases, which were immediately fatal, suffered a subnormal temperature and other evidences of collapse. Resolution by crisis, seven; by lysis, twelve; persistently high temperature until death, four.

*Group 3.*—Thirteen cases: No change in temperature, pulse, and respiration, which were within normal range; three cases fatal; four cases septic; three cases sharp rise in temperature—one to three days after frank symptoms or signs; two by crisis, one by lysis.

### SUMMARY

The onset of symptoms is generally accompanied by a sharp rise in temperature, lasting less than the symptoms, and unaccompanied by a proportional change in the pulse and respiration level.

Resolution is more frequently by lysis than by crisis. Occasionally there is no change until one to three days after onset of symptoms or none at all.

The convalescent pre-embolic septic temperature may be due to the usual wound complications, or more significantly, to a latent thrombophlebitis.

The prognosis is better in those without a convalescent septic temperature.

The following is the incidence of specific symptoms:

### Incidence of Specific Symptoms

*Bloody sputum:* Autopsied cases, two; pulmonary embolus, four; pulmonary infarction, seventeen; twenty-three out of a total of eighty-four cases.

*Signs of fluid:* Five dry tap, of which four had no sputum; five positive tap, of which four had no sputum.

*Physical signs:* Autopsied cases, three; *pleural pain, 2;* asymptomatic, 11. Other cases, 35; *pleural pain, 45;* (of which twenty-five showed both symptoms and physical signs).

### X-RAY FINDINGS

*Autopsy Findings and Physical Signs.*—At the time of the lodging of the embolus, there are no characteristic X-ray features. In only five of the twenty-three X-ray reports was a diagnosis suggestive of pulmonary infarction; in one the X-ray report was positive twelve days after the onset; in another, eight days; in a third, two weeks.

# PULMONARY INFARCTION AND EMBOLISM

The X-ray report in the first few days of infarction is vague: "Congestion, haziness, or diffuse mottling, and accentuated hilum shadows which suggest a pneumonitis."

In about five days the signs are those of bronchopneumonia, or suggest a pleural effusion. The sequence of changes in the röntgenogram of pulmonary infarction is well shown in the following: "Pneumonitis and congestion in right lung, not a pneumonia." Ten days later, "Massive pleural effusion in lower two-thirds of right chest." Five days later, "Signs of pulmonary infarction or of pneumonia with thickened pleuræ in right chest." Fifteen days later, "Right pulmonary emboli. More likely bronchopneumonia." Two weeks later, "Encapsulated fluid in lower two-thirds of right chest."

This is paralleled by the pathological sequence of compensatory hyperæmia of the collateral circulation, followed by local consolidation and occasionally by pleural involvement, which may be productive or exudative, with, finally, the cicatrization of hæmorrhagic area. Obviously, the wedge-shaped or cuboidal area of pulmonary consolidation, which we expect off-hand in a röntgenogram of diagnostic import, is late in appearing. As in many other instances, the X-ray findings should be viewed in the light of the clinical manifestations. We are taking the liberty of summarizing an excellent discussion on this subject by Wharton and Pierson.[6]

Within twenty-four hours following the onset of the symptoms of pulmonary infarction, the film shows clouding of the costophrenic angle, which also occurs in bronchopneumonia and in pleural effusion. In the former, however, the clinical reaction is disproportionately great in relation to the pathology as demonstrated in the röntgenogram.

In more severe cases of pulmonary infarction, the lung density (in the nature of the lesion, most frequently in the dependent portions of the lung) is increased and is fairly well delimited. Frank pleural changes occur between four and ten days after onset and involve the same area as the pulmonary infarction. They consist of a network of fine lines superimposed on the area of increased pulmonary density and indicative of the formation of bands of thickened pleuræ. The pleural changes persist longer than the pulmonary changes, being a matter of months, very frequently, whereas the latter is a matter of days.

The pulmonary density in infarction differs from that in lobar pneumonia in being less marked and in the absence of a lobar distribution, as a rule.

The X-ray film of pulmonary infarction, as contrasted to that of bronchopneumonia, manifests a more marked pleural reaction and sharper outline of the involved area. In moderate pleural effusion, the shadow is denser and a meniscus is present, while the pleural reaction is slighter. In slight pleural effusion, the diagnosis is more difficult. Clinically, however, the constitutional reaction is not as severe in pleural effusion.

X-ray films of post-mortem cases of pulmonary infarction and embolism might yield profitable information correlating pathological and X-ray manifestations.

## PHLEBITIS AND PULMONARY SYMPTOMS

*Operation.—Excision of varix of left saphenous vein for phlebitis of left saphenous—* (a complication of correction of retroverted uterus).

*Venous Symptoms.—*Saphenous phlebitis preceding pulmonary symptom tenth post-

operative day. Thrombosis in left leg tenth post-operative day. Pulmonary symptoms—seventh post-operative day. Hæmatoma about spleen following pulmonary symptoms. Phlebitis right saphenous twelfth post-operative day. Pulmonary symptoms—sixth post-operative day. Phlebitis of left calf nineteenth to twenty-sixth post-operative day. Pulmonary symptoms seventh to twenty-first post-operative day. Pain in right knee and right thorax seventh post-operative day. Pulmonary symptoms—bloody sputum twelfth post-operative day. Phlebitis of left saphenous eleventh post-operative day. Pulmonary symptoms—bloody sputum eighth to tenth post-operative day. Phlebitis of left leg eleventh post-operative day. Pulmonary symptoms—bloody sputum nineteenth post-operative day. Pain and swelling in both legs thirteenth post-operative day. Pulmonary symptoms—bloody sputum fourth post-operative day. Phlebitis of both legs. Pulmonary symptoms—infarction right chest. (Time of onset not noted.)

In five cases phlebitis occurred before pulmonary symptoms—two died.

In six cases phlebitis occurred after pulmonary symptoms—one died.

The latter may be explained by the friability of the mural thrombus in the early stage of its formation. While the lumen is still adequate for the blood stream distal to the partial occlusion. we may expect distant embolic phenomena earlier than the local signs and symptoms due to occlusion. That there are more embolic phenomena earlier in thrombosis is apparent from Graph III.

In sixteen autopsied surgical cases of pulmonary embolism, five occurred in the first week post-operative; nine after the first week. In the former group, one suffered from fractured ribs and was not operated on, and another arrived *in extremis* from uncertain cause necessitating an exploratory laparotomy. Clearly in these cases, the causes for embolism antedate hospitalization.

The preponderance of fatal cases after the first week seems to be due to the larger embolus which is dislodged from the more cohesive thrombus present at that time.

Among six cases of phlebitis complicating appendectomies, pulmonary infarction occurred in two—one apparently passing unnoted but for the nurse's record of bloody sputum. In the other cases, pulmonary emboli may have been asymptomatic, granted a normal lung, or the symptoms were unrecorded, or organization of the thrombus occurred *in situ*.

The prognosis appears fair in cases of pulmonary symptoms associated with phlebitis. The reason which some have assigned for this is the attitude of watchful waiting due to the knowledge of the existence of the latter condition. Though this may be a factor where phlebitis precedes, a more important one seems to be the anatomy of the region which becomes obviously involved. In the autopsied cases, thrombosis was on a large scale, spreading from the femoral vein to the iliacs. Thrombosis of the saphenous vein involves a vessel of far smaller lumen and less rapid blood flow so that significant embolic fragments are not dislodged.

### DIFFERENTIAL DIAGNOSIS BETWEEN BRONCHOPNEUMONIA AND PULMONARY INFARCTION

*Onset and History.*—Bronchopneumonia is frequently preceded by a pre-operative bronchitis, etc., or there may be a history of aspiration during

anæsthesia. Pulmonary infarction seldom has a clear-cut history of respiratory involvement, but may be associated with a phlebitis. The onset in bronchopneumonia is insidious. In pulmonary infarction, there may be prodromal symptoms suggesting bronchopneumonia, and a preceding irregular temperature, but there generally—not invariably—is an episode of a sharp rise in temperature. The onset of pulmonary infarction tends to be later than that of bronchopneumonia in the post-operative course.

*Pain.*—In bronchopneumonia, this symptom is not marked. In pulmonary infarction, this was the most frequent symptom we found. It is marked in its severity.

*Sputum.*—In both, sputum may be absent. In bronchopneumonia, it is muco-purulent with, perhaps, an admixture of blood. In pulmonary infarction, it is bloody and frothy, the blood being bright red, or clotted.

*Respiration.*—There is increased rate of respiration in bronchopneumonia. In pulmonary infarction, there may be a transient increase at the onset.

*Physical Signs.*—These may be the same in both conditions. In bronchopneumonia, it is far more likely that the signs will be diffuse. There rarely is tubular breathing. The breath sounds are harsh; there are crepitant râles.

In pulmonary infarction, the signs are variable—there may be localized friction rubs or crepitant râles lasting two or three days, or consolidation of the lower lobe—localized and not extensive; the signs may be of extensive plastic pleurisy or serous effusion; on exploratory puncture, however, fluid may not be obtained.[7]

*Duration of Symptoms and Physical Signs.*—Generally, the course in bronchopneumonia is more protracted, and the duration of fever is fairly parallel to the duration of signs. In pulmonary infarction, the temperature subsides considerably before the physical signs or symptoms.

*Condition of Patient.*—In pulmonary infarction, generally after the first reaction to the onset has subsided, the patient is in fairly good general condition in spite of the pain and expectoration.

### MEDICAL CASES OF PULMONARY EMBOLISM AND INFARCTION

Pulmonary embolism and infarction from the medical side do not present a homogeneous class, and include some unique cases. Between 1881 and 1927, thirty-two cases of pulmonary embolism and infarction came to autopsy on the First Medical Service.

The following is the distribution of cases in the entire series: Chronic myocarditis, thirteen; chronic cardiac vascular disease, eight—twenty-two cardiovascular; aortic aneurism, one; lobar pneumonia, three; typhoid fever, two; idiopathic pulmonary infarction, two; tuberculous pleurisy, one; post-partum pulmonary infarction, one; chronic nephritis, one.

### CARDIOVASCULAR DISEASE

I. *Autopsied Cardiovascular Cases.*—Examination of post-mortem records in cardiovascular disease complicated by pulmonary infarction reveals several characteristics wherein this type differs from the case on the surgical side.

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I. In spite of stasis, which in some cases is generalized, primary thrombosis in the peripheral veins is rare as a source for pulmonary infarction. In this series (Table IV) there is just one case, No. 7, in which this possibility was entertained.

TABLE IV.

*Summary of Twenty-two Autopsied Cases of Cardiovascular Disease.*

CASE 1.—Male, fifty-three years of age. Disease—cardiac hypertrophy and dilatation. Previous symptoms—*embolic infarcts* (source of embolus indicated): Fragmented thrombi in both ventricles near papillary muscles; emboli in both divisions of pulmonary artery; infarcts—bases.

CASE 2.—Male, sixty years of age. Disease—cardiac hypertrophy and dilatation. Previous symptoms—*embolic infarcts* (source of embolus indicated): Small thrombi in both ventricles; passive congestion of lungs; infarcts—bases; emboli—corresponding arteries.

CASE 3.—Male, sixty-two years of age. Disease—cardiac hypertrophy and dilatation; myocarditis. Previous symptoms—*embolic infarcts* (source of embolus indicated): Coronaries sclerosed—almost occluded; thrombus and fibrous myocarditis—right heart; infarcts and passive congestion of both lungs; pericardial and pleural effusion.

CASE 4.—Male, fifty-nine years of age. Disease—cardiac hypertrophy and dilatation; myocarditis. Previous symptoms—*embolic infarcts* (source of embolus indicated): Thrombi—right auricle; infarcts—all lobes; passive congestion of lungs.

CASE 5.—Female, fifty years of age. Disease—aortic aneurism. Previous symptoms—*embolic infarcts* (source of embolus indicated): Luetic aneurism of arch with lamellated clot; small mural thrombi in right auricle; in right and left pulmonary artery—thrombi extending from right ventricle; left base consolidated.

CASE 6.—Male, forty-five years of age. Disease—arteriosclerotic endocarditis. Previous symptoms—*embolic infarcts* (source of embolus indicated): Torn thrombi in right ventricle; left pulmonary artery—embolus; left lung anæmic; right lung multiple infarcts.

CASE 7.—Male, fifty years of age. Disease—bronchopneumonia; myocarditis (chronic). Previous symptoms—*embolic infarcts* (source of embolus indicated): Syphilitic endocarditis; mural thrombus in left ventricle—about one-half of cavity filled; interference with function sufficient to cause decompensation; infarct left lung—probably from pelvis or leg; bronchopneumonia right base; kidney infarcts.

CASE 8.—Male, fifty-six years of age. Disease—coronary thrombosis; myocarditis (chronic). Previous symptoms (source of embolus indicated): Mural thrombus—right auricle; infarct—recent—left lung—lower; hydropericardium, thorax, peritoneum.

CASE 9.—Male, thirty years of age. Disease—chronic endocarditis; myocarditis (chronic). Previous symptoms—*embolic infarcts* (source of embolus indicated): Mitral and tricuspid vegetations—streptococcus viridans; one branch of right pulmonary artery is occluded by an old thrombus extending into the smaller branches; infarcts—right upper; left lower; pericarditis and pleurisy.

CASE 10.—Male, sixty-five years of age. Disease—coronary thrombosis; myocarditis (chronic). Previous symptoms—*embolic infarcts* (source of embolus not indicated): Pulmonary embolism, lower right lobe; cardiac infarct and aneurism of left ventricle; pleurisy with effusion.

CASE 11.—Female, forty years of age. Disease—chronic parenchymatous nephritis; myocarditis (chronic). Previous symptoms—*embolic infarcts* (source of embolism not indicated): Emboli in both branches pulmonary artery; infarct—right lower lobe.

CASE 12.—Male, fifty years of age. Disease—cardiac hypertrophy and dilatation; chronic diffuse nephritis. Previous symptoms—*embolic infarcts* (source of embolus not indicated): Thrombus—attached to fibrosed area left ventricle; pulmonary emboli—both branches of artery; infarct and pleurisy lower right lobe; chronic passive congestion of lungs.

Case 13.—Male, forty-one years of age. Disease—cardiac hypertrophy and dilatation; chronic nephritis (not diffuse). Previous symptoms—*embolic infarcts* (source of embolus not indicated) : Pulmonary embolus in branch to infarcted right base; passive congestion of lungs; kidney—infarcts.

Case 14.—Male, fifteen years of age. Disease—chronic endocarditis. Previous symptoms—*thrombosed peripheral veins:* Thrombosis of left jugular vein and subclavicle vein; marantic multiple pulmonary infarcts.

Case 15.—Female, seventy-one years of age. Disease—coronary thrombosis; chronic myocarditis. Previous symptoms—*thrombosed peripheral veins:* Atheromatous aorta and attached mural thrombi; occlusion of left coronary artery and main branch of pulmonary artery; fibrosis of wall of left ventricle—attached mural thrombus; multiple pulmonary infarcts; thrombosis of left external jugular and right ovarian.

Case 16.—Female, thirty-four years of age. Disease—chronic endocarditis; parenchymatous nephritis. Previous symptoms—*marantic infarcts:* Hæmothorax and peritoneum; coronary sclerosis; aneurism of aortic arch compressing pulmonary artery; bilateral pulmonary infarcts; mesenteric infarcts.

Case 17.—Male, fifty-one years of age. Disease—cardiac aneurism; chronic diffuse nephritis. Previous symptoms—*marantic infarcts:* Left ventricle—aneurism with adherent lamellated clots; pulmonary infarcts—multiple bilateral.

Case 18.—Female, seventeen years of age. Disease—chronic endocarditis. Previous symptoms—*marantic infarcts:* Hæmorrhagic infarcts of lungs; left empyema.

Case 19.—Male, fifty-four years of age. Disease—chronic endocarditis. Previous symptoms—*marantic infarcts:* Infarcts—right multiple pulmonary.

Case 20.—Male, fifty-seven years of age. Disease—cardiac hypertrophy and dilatation; chronic nephritis (not diffuse). Previous symptoms—*marantic infarcts:* Infarcts—multiple pulmonary bases.

Case 21.—Male, fifty-three years of age. Disease—aortic aneurism; pulmonary infarct "pneumonia". Previous symptoms—*marantic infarcts:* Infarcts—multiple pulmonary bases.

Case 22.—Female, fifty-three years of age. Disease—chronic and acute endocarditis. Previous symptoms—*marantic infarcts:* Chronic endocarditis—mitral and tricuspid; acute endocarditis—mitral; multiple pulmonary infarcts.

2. Pulmonary infarction is not necessarily embolic. In thirteen cases, the thrombus probably was metastatic, but in five of these, the source was not determined. In eight cases, pulmonary infarction was dependent on local marantic thrombosis, in the presence of chronic passive congestion, and the toxic and infective effects of the underlying disease.

3. The vessels, whose occlusion is associated with pulmonary infarction, tend to be of medium size—in fourteen cases.

4. In the rare instances when peripheral venous thrombosis occurs, it is predominately in the veins of the upper part of the body—two cases. (Of twenty-six cases of peripheral venous thrombosis collected by Welch,[3] seventeen were of the upper part of the body. "When we consider that the ratio of thrombosis of the upper extremity to the lower extremity is one to fifty, the relatively large number of the former associated with cardiac disease is certainly most striking." It may not be irrelevant in this discussion to cite the reason for the predominance of thrombosis in the veins of the upper part of the body on the *left* side,—the obliquity and greater length of the left innominate vein similar to those of the left common iliac vein.)

5. Death can seldom be attributed to the immediate effect of the embolus—one case, No. 6. (In the case of No. 7, above, cardiac embarrassment due to the large cardiac thrombus was probably contributory to death.)

From the clinical records of the above cases, we have not been able to determine any change in the level of temperature, pulse, and respiration caused by the onset of pulmonary infarction.

As would be expected, the pulmonary involvement plays but a minor part in the severity of the condition and is only a slight increment to the existing discomfort of the patient. It is of prognostic value because it reflects the extent of right heart decompensation and not because of its intrinsic significance. The age distribution is as follows:

| Age | | −9 | −19 | −29 | −30 | −49 | −59 | −71 |
|---|---|---|---|---|---|---|---|---|
| Autopsied cases | | — | 2 | 1 | 2 | 3 | 11 | 3 |

II. *Unautopsied Cardiovascular Cases.*—Examination of the records of the unautopsied cases, again indicates the marked preëminence of cardio-vascular disease in association with pulmonary infarction. Of fifty-six cases, thirty-one are cardiovascular. The age distribution is as follows:

| Age | | −10 | −19 | −29 | −39 | −49 | −59 | −69 |
|---|---|---|---|---|---|---|---|---|
| Cases | | 1 | 5 | 4 | 7 | 4 | 8 | 2 |
| Mortality | | 0 | 4 | 2 | 3 | 2 | 7 | 1 |

The incidence is more marked in the middle and last thirds of life, but not to such an extent as in the surgical cases. The distribution of cases between the sexes: Male, nineteen; female, twelve.

The higher incidence in males is even more marked in the autopsied cases: Male, sixteen; female, six.

III. *Symptoms.*—The manifestation of symptoms is very variable. In only two cases was there collapse followed by death. The other fatal cases suffered the more gradual death due to cardiac decompensation. The temperature-pulse-respiration reaction depends on the general condition of the patient rather than on the pulmonary infarct. Most of the patients—seventeen—had a constant increased temperature whose level was not interrupted by a significant rise to indicate time of infarction. Indeed, infarction probably is not the sudden process which it is in surgical cases, since the condition is preëminently marantic.

In one case there was peripheral venous thrombosis prior to the pulmonary symptoms. This, of course, does not mean necessarily that the peripheral thrombus was the source of the pulmonary infarct. Two cases suffered from visceral infarctions as well.

Characteristic bloody sputum was present in nineteen of the above series, one being marked also by hæmoptysis. It was absent in eleven cases. In the autopsied cases, bloody sputum was predominately lacking in thirteen, and present in seven. This reversal of the usual frequency may have been due to the moribund condition of the patients.

*Frequency of Pulmonary Infarction in Cardiovascular Conditions.*—One case was diagnosed as bronchopneumonia. Three cases were not considered as pulmonary infarction, though the symptoms and physical signs as recorded are very suggestive. Of thirty-eight cases of chronic cardiac valvular disease occurring between 1923 and 1925, the majority had an occasional hæmoptysis or other signs of pulmonary congestion. Of forty-five cases occurring between 1915 and 1917, three cases showed frank pulmonary infarction, three cerebral embolism, one phlebitis of the veins of the right leg and also thrombosis of the right posterior tibial artery.

# PULMONARY INFARCTION AND EMBOLISM

*Phlebitis and Pulmonary Infarction.*—Two cases of phlebitis were puerperal, and, strictly speaking, do not belong in the medical group.

In these cases, as in the surgical series, phlebitis frequently follows the pulmonary infarction; in five cases, particularly in No. 1 and No. 2, the history of pulmonary symptoms covers a fairly long period and suggests incipient tuberculosis—loss of weight, night sweats, etc. In pulmonary infarction, the localization of signs to the bases may be of differential value. (See Table V.)

## TABLE V.

*Summary of Ten Cases of Phlebitis and Pulmonary Infarction.*

CASE 1.—Female, twenty-two years of age. Presenting symptoms—history like incipient tuberculosis. Pain—mild. Sputum—hæmoptysis. Relation of phlebitis—three days after admission, all extremities. Previous history—six years before, typhoid with phlebitis of both legs; pulmonary infarct, two weeks before tonsillectomy; bilateral pleural pain. Symptoms of phlebitis and pulmonary infarction—right base—consolidation. Result—lived.

CASE 2.—Male, twenty-six years of age. Presenting symptoms—history like incipient tuberculosis. Pain—right chest and flank. Sputum—present. Relation of phlebitis—six weeks before admission, in right calf. Symptoms of phlebitis and pulmonary infarction—right base—400 c.c. bloody serum. Result—lived.

CASE 3.—Male, twenty-seven years of age. Presenting symptoms—history like incipient tuberculosis. Pain—left chest. Sputum—present. Relation of phlebitis—five days after admission, right leg—from ankle to femoral region. Symptoms of phlebitis and pulmonary infarction—bases flat. Result—lived.

CASE 4.—Female, twenty-one years of age. Presenting symptoms—thrombosis left arm. Relation of phlebitis—pulmonary symptoms; embolism; seventh day of thrombosis. Result—died.

CASE 5.—Male, thirty-seven years of age. Presenting symptoms—varicose vein, malaise, dyspnœa. Pain—gall-bladder region. Relation of phlebitis—ten days after admission, left femoral vein signs of phlebitis. Previous history—typhoid. Symptoms of phlebitis and pulmonary infarction—right axilla slightly dull; leucocytosis, diagnosed; acute cholecystitis. Result—lived.

CASE 6.—Female, sixty-three years of age. Presenting symptoms—103° for two months. Pain—right chest. Sputum—present. Relation of phlebitis—sixteen days after admission, right internal saphenous vein. Symptoms of phlebitis and pulmonary infarction—right base and axilla, impaired resonance. Result—lived.

CASE 7.—Female, thirty years of age. Presenting symptoms—105°. Pain—bilateral axillæ. Sputum—present. Relation of phlebitis—thirty-three days after admission, phlebitis bilateral. Previous history—four years before, right leg thrombosis postpartum. Symptoms of phlebitis and pulmonary infarction—twenty-three days after admission, subcrepitant left base. Result—lived.

CASE 8.—Female, twenty-seven years of age. Presenting symptoms—signs on admission and seventeen days after (vaginal examination)—104°. Pain—left chest. Sputum—hæmoptysis. Previous history—puerperium three weeks before. Symptoms of phlebitis and pulmonary infarction—left base—dull mitral insufficiency. Result—lived.

CASE 9.—Female, twenty-six years of age. Presenting symptoms—history like incipient tuberculosis. Sputum—present. Relation to phlebitis—miscarriage; thrombosis of pelvic vagina and inferior vena cava. Symptoms of phlebitis and pulmonary infarction—right base—consolidation; left posterior chest, three pints bloody serum; pretibial œdema. Result—died.

CASE 10.—Female, forty years of age. Presenting symptoms—aortic insufficiency; provocative salvarsan. Pain—left chest. Relation of phlebitis—left axillary and brachial vessels six days before infarction. Symptoms of phlebitis and pulmonary infarction—convulsion. Result—died.

The site of pain may be misleading. In Case No. 5, there was pain in the gall-bladder region, but no sputum. There was also a history suggesting the abdomen, probably due to an infarct in the region of the diaphragm.

In two cases, Nos. 1 and 7, there had been a previous phlebitis, which may have left a residuum to serve as focus for the later symptoms. Here, the pulmonary symptoms preceded the phlebitis. In two cases, there was a previous history of typhoid. These cases indicate the value of a complete history. It is probable that some of the idiopathic cases of pulmonary infarction, to be discussed below, may have some such basis.

*Typhoid Fever and Pulmonary Infarction.*—Between July 1, 1914, and 1917, the following was the partition of complications of typhoid fever. (See Table VI.) Sixty-four complications. Phlebitis (frequently associated with "tender" toes), twenty-one; respiratory (pulmonary infarction was diagnosed in only one instance), eight; bronchopneumonia (three were more probably pulmonary infarctions), six.

## TABLE VI.
### *Summary of Cases of Typhoid Fever and Pulmonary Infarction.*

CASE 1.—Male, thirty-four years of age. Onset in course of typhoid—twenty-third day. Pain—right and left chest. Sputum—present. Relation of phlebitis—twenty-fifth day, tender toes; thirty-second day, left calf. Chest findings—twenty-third day, friction rub; thirtieth day, bloody fluid. Result—lived.

CASE 2.—Female, thirty-seven years of age. Onset in course of typhoid—seventeenth day. Pain—left chest. Sputum—present eighteenth day. Relation of phlebitis—twenty-second day, tender right heel; pain along femoral vein; never any signs. Chest findings—eighteenth day, dull, left chest. Result—lived.

CASE 3.—Female, thirty-eight years. Onset in course of typhoid—thirteenth day, left chest; pulse 72–144; respiration from 20–44; nineteenth day; pain—right chest. Duration one month. Sputum—present seventeenth day. Relation of phlebitis—twenty-first day, pain left leg; thirty-first day, pain right leg; thirty-ninth day, pain lower abdomen. Chest findings—eighteenth day, dry crepitant râles left chest. Result—lived.

CASE 4.—Male, forty-nine years. Symptoms—temperature of 105°. Onset in course of typhoid—eighth day, hospital. Relation of phlebitis—left saphenous vein—typhoid bacilli present in blood. Chest findings—eighth day, slight dulness, right base. Pathological findings—myocardial degeneration, left lung, infarct; left femoral thrombus. Result—died.

CASE 5.—Male, thirty-five years of age. Symptoms—temperature of 101°. Onset in course of typhoid—fifteenth day, hospital to thirty-fourth day. Chest findings—left axilla—friction rub right base, dulness fifteenth to thirty-fourth day. Pathological findings—myocardial degeneration; emboli in pulmonary artery; right lower, infarct. Result—died.

Onset of pulmonary infarction is generally late in the course of the disease. Associated with the pulmonary infarction, there generally is a thrombophlebitis (exception No. 1) which may begin as "tender toes" due to irritation of the nerve endings in the wall of the thrombosed vessels, or

to thrombosis in vessels nourishing the nerves. As in other instances, tenderness along the course of the vein need not be accompanied by swelling of the tissues drained (No. 2). In case No. 3, pain in the lower abdomen might have been considered an intestinal perforation, had not the antecedent history pointed to a diagnosis of thrombosis of an abdominal vessel.

The cause of death in the two fatal cases seems to be attributable to myocardial degeneration and to septicæmia (No. 4).

It may be difficult to differentiate pulmonary infarction from intestinal perforation due to the common factor of shock, as the following case report indicates:

Fifteenth day of illness, the pulse suddenly became imperceptible. Skin—cold, clammy, and moist. White blood cells 26,000—two days previously, 5,000. Blood pressure 60/30. Temperature rose to 106°. Before she could be operated upon for suspected perforation, the patient died. At autopsy, there was no evidence of perforation or of peritonitis. The only positive change was a localized area of pulmonary congestion as in lobar pneumonia.

*Miscellaneous Group.*—The rarity of the occurrence of pulmonary infarction in acute rheumatic fever, a disease associated with hyperinosis, is apparent. Both patients were unusually old for the disease. In Case No. 3 the diagnosis was based on the therapeutic test. In the other case there was a lobar pneumonia secondary to pulmonary infarction.

Between July, 1914, and 1927, of 147 complications of acute rheumatic fever, three were "lobar" pneumonia, one phlebitis, and one pulmonary infarction. Examination of forty-two cases in that period showed many with signs of pulmonary congestion but none with the characteristic symptom-complex of pulmonary infarction. This, and some other diseases, emphasizes Aschoff's formula that thrombosis is a function of several variables.

The thrombosis and infarction complicating tuberculosis probably are cachectic.

Case No. 8 (Table VII) is another instance of a pitfall—the onset was abdominal pain, pointing to appendicitis.

TABLE VII.

*Miscellaneous*

CASE 1.—Female, sixteen years of age. Disease—chorea. Temperature—one week after tonsillectomy, 101°. Pain—present, left. Sputum—present. Symptoms of onset—rales only. Result—died.

CASE 2.—Male, forty-three years. Disease—acute articular rheumatism. Temperature—normal until fifteenth day, then 101–104°—septic; normal on twenty-first day. Sputum—present second day; hæmoptysis. Symptoms of onset—fifteenth day, consolidation left lower lobe; thirty-fifth day, condition cleared. Result—lived.

CASE 3.—Male, sixty-four years of age. Disease—acute articular rheumatism. Phlebitis—ninth day, left arm; right leg. Symptoms of onset—twentieth day, collapse, etc. Result—died.

CASE 4.—Female, eight years of age. Disease—acute bacterial endocarditis. Temperature—103°. Symptoms of onset—five weeks, collapse; two days later, collapse. Result—died.

CASE 5.—Male, seven years. Disease—acute bacterial endocarditis. Symptoms of onset—twenty-third day, collapse. Result—died.

CASE 6.—Female, twenty-nine years of age. Disease—tuberculous pleurisy. Temperature—101°. Pulse—112. Respiration—44. Symptoms of onset—collapse. Pathological findings—thrombus infarct, lower right. Result—died.

CASE 7.—Male, twenty-seven years of age. Disease—tuberculosis, dry pericarditis. Symptoms of onset—bedpan, sudden death. Result—died.

CASE 8.—Male, forty-two years of age. Disease—tuberculosis and syphilis. Pain—abdominal. Sputum—present three days after pain. Symptoms of onset—onset, "append." fine râles. Result—lived.

CASE 9.—Male, twenty-seven years of age. Idiopathic—temperature 100°. Pulse—148. Respiration—48. Pain—present. Sputum—present. Symptoms of onset—collapse. Result—lived.

CASE 10.—Female, forty-eight years of age. Idiopathic—cough, bloody expectoration, one month. Temperature—increased. Symptoms of onset—right base, consolidation, crepitant râles. Pathological findings—infarcts right base. Result—died.

CASE 11.—Male, forty years of age. Idiopathic—cough, bloody expectoration. Temperature—104°. Pulse—108. Respiration—24. Pain—abdomen. Symptoms of onset—bases slightly dull; fine râles. Result—lived.

CASE 12.—Male, thirty-four years of age. Idiopathic—onset as pneumonia; chill; fever. Pain—back; right flank. Symptoms of onset—right axilla; crepitant râles. Result—lived.

CASE 13.—Male, twenty-seven years of age. Idiopathic—onset as pneumonia; chill; fever. Temperature—103°. Pain—epigastrium. Sputum—present three days after, pain. Symptoms of onset—no physical signs. Result—lived.

CASE 14.—Male, seventy years of age. Idiopathic—high blood pressure 250/130. Temperature—99°–101°. Symptoms of onset—cerebral hæmorrhage. Pathological findings—laminated clot in pulmonary artery, source? Result—died.

CASE 15.—Male, twenty-five years of age. Lobar pneumonia. Symptoms of onset—no details. Result—lived.

CASE 16.—Male, thirty-six years of age. Lobar pneumonia. Symptoms of onset—delirium tremens, sudden collapse. Result—died.

CASE 17.—Male, forty-two years of age. Lobar pneumonia. Temperature—100°. Pulse—80. Respiration—28. Symptoms of onset—collapse; loud râles. Pathological findings—pulmonary thrombosis—vein; left iliac vein; thrombosis. Result—died.

CASE 18.—Male, thirty-eight years of age. Lobar pneumonia—pneumococcus septicæmia. Temperature—100°–103°. Pathological findings—lobar pneumonia; left lung; infarct, right lower; septic. Result—died.

CASE 19.—Female, thirty-seven years of age. Disease—hepatic cirrhosis; chronic diffuse nephritis. Temperature—99°. Pulse—100. Respiration—26. Pathological findings—infarct, right lower lobe; atelectatic bases. Result—died.

CASE 20.—Female, thirty-six years of age. Disease—acute myelitis. Pathological findings—infarct, subpleural. Result—died day of admission.

CASE 21.—Male, nineteen years of age. Disease—chronic cardiovalvular disease. Temperature—100°. Pulse—90. Respiration—24. Pain—right shoulder. Phlebitis—left calf phlebitis. Result—died (cerebral embolism).

CASE 22.—Female, twenty years of age. Disease—chronic cardiovalvular disease. Temperature—103°–100°. Pulse—130. Respiration—28, constant. Pain—left shoulder. Miscellaneous symptoms only—consolidation at lower angle left scapula. Result—died.

CASE 23.—Male, thirty-three years of age. Disease—chronic cardiovalvular disease. Temperature—100°. Pulse—100, constant. Respiration—20. Pain—present, precordial. Sputum—present. Miscellaneous symptoms—no physical signs of infarction. Result—improved.

Case 24.—Female, fifty-seven years of age. Disease—chronic cardiovalvular disease. Temperature—98.2°. Pulse—45. Respiration—20. Pain—present, precordial. Sputum —present. Miscellaneous symptoms—consolidation; subcrepitant and crepitant râles. Result—died.

In idiopathic pulmonary infarcts, the onset may suggest tuberculosis or lobar pneumonia. The former mode has already been discussed. In regard to the latter, our data are inadequate, and, for the sake of completeness, we present a summary of the findings in pulmonary infarction as against lobar pneumonia from Conner's [*] article: "The signs of consolidation are of short duration; there are anomalous, protracted, pleural signs; there may be signs suggesting fluid but exploratory puncture is negative; sputum is not rusty as in pneumonia, but bloody or clotted; the course of the temperature is atypical. In all of our five cases there was bloody sputum. The location of the pain and the physical signs were varied."

Our evidence in pulmonary infarction secondary to lobar pneumonia is inconclusive. One case, diagnosed as lobar pneumonia, was actually a pneumococcus septicæmia, with many local manifestations, including a septic infarct of the right lower lobe. The other case, on autopsy, was found to have a pulmonary venous thrombosis, as well as a thrombosis of the left internal iliac vein. This is the only instance of primary pulmonary venous thrombosis which we have been able to find in our series.

Twenty cases of leukemia, occurring between 1914 and 1927, were examined. In one case of lymphatic leukemia, "phlebitis" of the left calf and pleurisy with effusion appeared practically simultaneously, with no change in temperature, pulse, and respiration.

The association of thrombosis in the diseases involving changed conditions of the blood is thus rare. It seems that stasis and toxic factors are more important.

## SUMMARY

An intensive study has been made of pulmonary infarction and embolism on the basis of a very large number of clinical case records, autopsy reports and X-ray findings. It has been difficult to correlate the many interesting. facts which have been brought to light.

Thrombosis is a very frequent process which occurs conservatively in surgery and on the border line of the pathological in old age, and relatively infrequently in association with its characteristic train of unfortunate events. The determining factor is not the thrombus itself, but the type of tissue reaction to the thrombus—complete organization by the intima or organization with canalization being least threatening.

Thrombi in the swifter current of large veins are more readily fragmented and so are early associated with embolic pneumonic symptoms, such as occur within the first week post-operatively, and, as our analysis of data shows, presage the sudden symptoms of massive pulmonary embolism.

Thrombosis with resultant embolism cannot be primarily attributed to

differences among standard technics, to the operative position of the patient, or even to infection at the region of operation. In the fifteen autopsied surgical cases of pulmonary embolism we have found the distribution among types of operation to be inconclusive. In this series we have noted the occurrence of slight pulmonary signs and symptoms which we particularly wish to stress because of their significance as a herald of the cataclysmic events.

It has been attempted to evaluate the importance of pulmonary embolism as the cause of sudden death. Cardiac embarrassment appears from the data to be more important than the sudden encroachment on the margin of safety of lung tissue. The symptoms of pulmonary embolism are strikingly similar to those of sudden cardiac death as in coronary occlusion.

Traditionally, emphasis has been put on the importance of an immediate ante-mortem cause for precipitating the embolism. In several instances, the obvious age of the pulmonary embolus indicates the fallacy and we profess skepticism as to any essential significance of straining at stool, sitting up in bed, and so forth.

In younger individuals, pulmonary infarction is more frequent than massive pulmonary embolism. The onset is earlier and the course mild. We attribute this to the better general circulation because of which thrombotic fragments are washed away and the larger, more disastrous thrombi are not enabled to form later in the post-operative course.

In general, the onset of symptoms is accompanied by a sharp rise in temperature, of shorter duration than the symptoms, and unaccompanied by proportionate changes in pulse and respiration.

X-ray findings in pulmonary infarction are necessarily only suggestive, as the early condition is one of hyperæmia followed by local consolidation, and occasionally by pleural involvement before the terminal cicatrization and formation of the wedge-shaped area.

When phlebitis is associated with pulmonary symptoms the prognosis is better, not particularly because of a change in prophylaxis, but due to the more favorable anatomy of the thrombosed vein.

In cardiovascular pulmonary infarction, the cardiac thrombi and local passive congestion associated with heart failure are important. In contrast to surgical pulmonary infarction, this type is not accompanied by significant changes in symptoms.

In the course of typhoid fever, pulmonary infarction occurs late. Occasionally, peripheral phlebitis apparently follows a pulmonary infarction and may be due to the same cause instead of the former causing the latter.

Pulmonary infarction is unimportant in other medical conditions.

### CONCLUSIONS

1. Minor degrees of thrombosis, infarction and embolism are of great frequency.

2. Only the grosser forms give clinical manifestations.

3. Many instances are undoubtedly unrecognized.

4. Occasionally other conditions, especially cardiac failure, simulate embolism.

5. The vital factor is the condition of the heart.

6. No age is immune, but the probability of fatal outcome from disease, injury or surgical procedure increases with advancing years.

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# DIAPHRAGMATIC HERNIA

REPAIR BY TWO-STAGE OPERATION EMPLOYING PRELIMINARY
EXTRA PLEURAL THORACOPLASTY

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DURING the last two decades a considerable literature has grown up on the subject of diaphragmatic hernia. From the first case that Ambrose Paré is credited with having described in 1610, until 1908, according to Arnsparger,[1] diaphragmatic hernia had not been recognized more than ten times off the necropsy table. As late as 1912 Griffin collected 690 cases of this condition, of which only fifteen had been recognized during life. But the record has been quite different during these last two decades; as witness the Mayo Clinic's report of fifty-one cases since 1908, with twenty-seven operations and twenty-two survivals, while L. B. Morrison[2] reports that between April, 1922, and June, 1924, he made the diagnosis of diaphragmatic hernia thirty times by X-ray.

Previous to that time, Morrison had reported twelve other cases. All his were cases of congenital hernia of a portion of the fundus through the œsophageal hiatus in the diaphragm. The patients varied in age between six and seventy-six years. The youngest one had presented a history of vomiting from early babyhood, and was a little suggestive of pyloric obstruction. Most of his patients were sent in for gastric studies because of symptoms suggestive of peptic ulcer. The most constant history was that of pain or distress just above or anterior to the ensiform cartilage. The symptoms sometimes resembled those of gall-bladder disease. Difficulty in swallowing, regurgitation and vomiting were frequent. X-ray diagnosis frequently was possible only after several examinations. In order to demonstrate the hernia, of course, it is necessary to X-ray the patient at a time when an abdominal viscus is projecting above the diaphragm and maintaining a patency that will allow gas or barium to enter the heriated portion. It is probable that the symptoms in few of these cases reported by Morrison were severe enough to have justified surgical treatment.

There has been some expending of energy upon the classification of these herniæ. A diaphragmatic hernia is usually defined as a protrusion of an abdominal viscus, or abdominal viscera, through the diaphragm into the thoracic cavity. The opposite condition of protrusion of a thoracic viscus into the abdominal cavity would also meet the requirements, but seldom, if ever, occurs, owing to three factors: (1) The greater fixity of the thoracic viscera, (2) the, in general, greater weight of the abdominal viscera, and the ease with which they displace the lighter thoracic viscera, and (3) the negative pressure in the thorax with the consequent tendency to suck the abdominal

viscera up gradually during the respiratory cycle. Woolsey[3] says that dia-
phragmatic herniæ are best classified as follows:

1. Congenital. (Present at birth.)
   (a) False.
   (b) True.
2. Acquired. (Employed in the same sense as acquired inguinal.)
   (a) False.
   (b) True.
3. Traumatic.

According to Harrington,[4] the congenital and acquired herniæ usually
occur (a) through the hiatus pleuroperitonalis, (b) through the dome of the
diaphragm, (c) through the œsophageal hiatus, (d) through the foramen
Morgagni, (e) through an embryonic fusion point of the diaphragm. The
traumatic ones may occur anywhere, especially those due to perforating
wounds. Those due to indirect injury usually occur through an embryonic
fusion point. But such data and classifications on the bases of site, embry-
ology or etiology, while interesting philosophically, have little significance
from the point of view of clinical surgery.

The operative treatment of diaphragmatic injuries apparently dates from
1886, when Ricolfi reported the operative cure of a stab wound. Neumann,
in 1888, operated in the first case of diaphragmatic hernia in which the
hernial contents did not protrude through the thoracic wall. In 1893 both
Marana and Amante successfully repaired stab wounds of the diaphragm.
But it has been only within the last two decades, and mostly within the last
one, that the real progress has been made in operative treatment.

The approaches employed by the different surgeons have been varied.
They have been abdominal, thoracic and combined. For the abdominal route
an incision parallel to the costal margin has usually been employed, though an
upper left rectus incision is sometimes used. The thoracic approaches have
sometimes been made through openings provided by rib flaps, but more
frequently by intercostal incisions, sometimes with resection of the two
adjacent ribs. The abdomino-thoracic approach has been made, either begin-
ning as an abdominal incision and then extending into the chest, or probably
more frequently beginning as a thoracic incision and then extending through
the lateral aspect of the diaphragm and the abdominal wall. This latter
approach naturally provides the best exposure and the greatest freedom of
manipulation. It is probably the best incision for a very large hernia, but for
many smaller ones would not be necessary. Each case, of course, is an indi-
vidual problem. A few years ago, in the repair of inguinal herniæ, one heard
the various surgeons saying that they did a Bassini, a Halsted, or a Ferguson
operation as the case might be. Now, it is doubtful that any large per cent.
of the surgeons could tell off hand the differences between those operations.
They know the procedures employed in all, but do not know them as belong-
ing to any particular operation. Their view is a little more inclusive. To

them each inguinal hernia is a problem in plastic repair surgery, and each condition has to be met in the way best for that individual patient. And, in deciding what is best each time, the extent of the hernia and the condition of the tissues are the main factors, though age, social position and employment are factors that also enter. So, though we find Sauerbrüch, Willy Meyer and P. E. Truesdale preferring the thoracic approach, and find Harrington, with his extensive experience and excellent results, preferring the abdominal approach for most cases, we find the sane and thoughtful Carl A. Hedblom summing up the law and the prophets by deciding according to every individual case.

Now, after the matter of incision has been decided upon, there are several other items that have contributed to making the repair of diaphragmatic herniæ more frequently undertaken with success. One of these is the fact that a Sauerbrüch chamber is no longer necessary for chest operations. The ordinary nitrous oxide-oxygen apparatus (such as the Gwathmey), in the hands of a good anæsthetist, will maintain sufficient intra-thoracic pressure and keep the lungs sufficiently expanded to make chest work reasonably safe and satisfactory. The division or exersis of the phrenic nerve (Sauerbrüch, Kreuter,[5] Harrington), usually in the neck but possibly in the chest, will give a paralysis of the diaphragm that will make the operation easier and give better assurance of a firm repair; though it probably increases the chances of post-operative pulmonary complications. Gastric lavage, before the beginning of the operation, and the leaving of the stomach tube in situ until the operation is completed, or nearly so, as advocated by Harrington, has many advantages. It decreases the chances of aspiration pneumonia. It helps the surgeon to identify the cardia and it relieves the stomach of gas, and thus aids in its reduction into the abdominal cavity. When the operation is performed by the abdominal route, the use of the stiff rubber tube, suggested by C. H. Mayo, should frequently be of considerable aid in cases where there is difficulty in reducing the herniated viscera because of the suction exerted on them by the negative pressure of the thorax above the constricting ring of the diaphragmatic opening. C. H. Mayo[6] inserts a stiff rubber tube from the abdomen through the hernial opening into the thorax, thus permitting air to enter the pleural cavity, thereby overcoming the suction by equalizing the pressure in thorax and abdomen, and so facilitating the return of the abdominal viscera to their proper place. The repair proper is usually done with cromicized catgut, but there should also be used a sufficient number of interrupted nonabsorbable sutures of silk or linen to insure the continued apposition of the diaphragmatic tissues for some time after the chromic catgut may have become absorbed.

Our experience with diaphragmatic herniæ in the human is limited to the one case that we are reporting, but the unusual extent of the defect in the diaphragm necessitated the adaptation of an operative procedure that we feel will allow a number of patients to be cured in the future that have been

hopeless in the past. Our patient was a boy of sixteen, whose diaphragm had been ruptured nine years previously, in an automobile accident. The rupture had increased in size, incarceration of abdominal viscera in the thorax had become more frequent, and signs of cardiac decompensation—presumably from pressure—were beginning. With an unusually fine and sane attitude, they laid the thing before me and stated that their son's condition during the last few months had become so much worse that they thought he could live only a short while longer, unless something were done. They felt that any operation would be a serious undertaking, but that if any method could be devised that would give him a reasonable chance to come through alive and be cured, he and they wanted it tried. After examining him, I agreed with them and asked for time to think it over.

We considered a number of procedures. We thought of suturing the stomach into the defect, or of suturing it to the abdominal wall, as Harrington reports doing recently in a similar case that had an opening in the diaphragm so large that he could not close it. We also considered trying a fascia lata transplant to fill the defect. Finally the correct idea struck us,

Figs. 1 and 2.—These two X-rays in July, 1923, taken after a barium meal, show the extent of the defect in the diaphragm at that time. In the first plate the stomach may be seen passing into the chest near the mediastinum, while in Fig. 2 the colon is herniated through the lateral portion of the diaphragm near the chest wall.

however, and surprised us by its simplicity. It was just to do a preliminary extrapleural thoracoplasty, the operation devised by Sauerbrüch and now constantly done for obliterating the cavities of chronic empyema, for certain cases of bronchiectasis and for unilateral tuberculosis with pleural adhesions. Such a procedure, of course, would allow the closure of almost any sized defect in the diaphragm. All one had to do was to decrease the circumference sufficiently, and the area to be covered by the diaphragm would be correspondingly decreased. After that, the repair of the diaphragm itself should be a relatively simple procedure. This was the procedure employed. The only fear we had, practically, was the development of an empyema. We knew

that it would be necessary to do a transpleural operation for the repair, and knew that the chances were that the chest would fill with fluid thereafter. If that fluid should remain sterile, we would be all right, but if that fluid should become infected and an empyema develop, then there would be a condition for which we would have no adequate treatment; for we felt that after nine years of compression the lung would not expand sufficiently to fill the left chest, and that we could not collapse the chest wall sufficiently to bring it down to the lung. Now one or the other of these would probably be necessary in order to cure an empyema. For an empyema thoracis is seldom cured until dead space is obliterated and the visceral and parietal pleura are brought into contact.

We did the operation as we had planned, however, and cured the diaphragmatic hernia. The patient developed a sterile fluid in the left thorax that became purulent shortly after he got a septic sore throat. During the course of some nine months' treatment, though, we cured the empyema thoracis without approximating the visceral and parietal pleura. He still appears to have a dead space in his left chest, but the lung has expanded some. The only treatment he had was the drainage of the chest and alternate daily irrigations with Dakin's solution and neutral acriflavine 1-2000. During this time he went wherever he desired. He was fed unusually well, stayed in the sunshine constantly, and, I fear, annoyed his neighbors somewhat by playing a trombone, under doctor's orders, to expand his lungs. Eleven months after he went to the hospital for his first operation he is cured of his diaphragmatic hernia and of his subsequent empyema. He is well and hearty, and weighs eighteen pounds more than before we started working on him.

Report of case in detail follows:

CASE I.—J. C. C., white, male, sixteen years old.

*Family History.*—Father and mother living and well, as are also one brother, three half-brothers, one sister and one half-sister.

*Past History.*—Patient had influenza before his injury, in 1918, and since then has had mumps, whooping cough, chicken-pox and measles. Aside from these contagious diseases and the disability incident to the condition here reported, he has been healthy.

*Present Illness.*—At the age of six years he was run over by an automobile. He was taken to the Watts Hospital, where he remained four days. It was thought at the time that he was bleeding internally, but an operation was not deemed necessary. About two years later, there began to occur phenomena that he referred to as "his stomach's going away." This occurred about once a week and lasted about two hours at a time. During the attacks his intestines seemed to leave his abdomen, which became flatter, he had pain in the chest and abdomen, and became short of breath. Five years after the accident the patient consulted Dr. Waldo Boone, who made a diagnosis of diaphragmatic hernia, and investigated the matter of having the hernia repaired, but without receiving any surgical encouragement. A year later, the patient had an interesting attack of appendicitis. The patient says that the attack began with pains in the lower abdomen followed by nausea and vomiting. Then the pain localized to the right lower quadrant of the abdomen. Dr. L. S. Booker operated upon him for an acute abdomen, made a left upper rectus incision and removed a ruptured appendix from the thoracic cavity, through the abdominal incision and the hole in the diaphragm. The patient made a good recovery, but after that his "stomach began to go away oftener and oftener." The attacks became

more severe and lasted longer. The last time that his stomach and a portion of his intestines became incarcerated in the thorax, the attack lasted nine hours.

*Physical Examination.*—The patient was a fairly-well nourished, sixteen year-old boy. His face was slightly cyanotic during attacks. At other times it was ruddy. He looked healthy. His general physical examination revealed an essentially normal youth, with the exception of enlarged tonsils, an upper left abdominal scar, and the chest condition. The respiratory excursion on the left side was diminished, the point of maximum impulse of the heart was to the right of the sternum, and breath sounds were absent from the left chest. Instead, frequently, peristalsis was audible.

Wassermann was negative. Urine was normal, except for a faint trace of albumen. The white blood cell count was 6,800, the hæmoglobin 75 per cent., and the red blood cell count 4,800,000.

*June 25, 1927, X-ray Report—Stereoscopic Examination.*—"The stomach and part of the large bowel are located in the left chest. Opening through diaphragm appears very large. The stomach goes through the mediastinum, and the colon out near the chest wall. T. C. Kerns."

*First Operation—July 19, 1927.*—Extrapleural thoracoplasty—left. Under nitrous-oxide anæsthesia.

A long curved incision was made, beginning at about the level of the eighth dorsal spinous process at the costovertebral angle and extending downwards and forwards. The skin, fat and muscles were freed and portions of the five lower ribs—6, 7, 8, 9, 10— were resected subperiosteally and extrapleurally. Approximately six inches of the posterior portions of each of these ribs were removed. A very good collapse of the chest wall was obtained. The skin was closed with interrupted sutures of silkworm gut and a small rubber tissue drain left in for a few days to take care of any ooze or serum. A pad was placed over the wound to obliterate dead space and keep the chest wall pushed in. His convalescence from this procedure was uneventful, except from a slight infection in the wound. On this account he was kept in the hospital until August 13, when he was discharged with the wound healed.



FIG. 2.—See Fig. 1.

It had been our original intention to proceed with the second operation two weeks after the first, but owing to the wound infection, it was decided better to send him home for a month or two in order to decrease the chances of a pleural infection in the second operation, the incision of which would have to cross the first scar. This was done, and he was given daily sun baths over the scar while at home.

After the thoracoplasty, his "stomach never went away again," he said. Subsequent X-rays, however, did show parts of his stomach and intestines in the chest, but it is

probable that his feeling of relief was due to the fact that the tension on the hernial ring had been relieved, and he consequently did not have an incarceration. The shortness of breath became worse, however, and the dyspnoea was frequently accompanied by a pulse rate above 140.

*Second Operation—September 24, 1927.*—Repair of Diaphragmatic Hernia. Splenectomy. Nitrous-oxid anæsthesia. Gwathmey apparatus.

A long intercostal incision was made between the regenerated eighth and ninth ribs. The ribs were soft and did not interfere with the operation. The incision during the operation was extended on down into the upper left abdomen, about one and one-half inches, in order to gain better access to the diaphragm. The entire stomach, the spleen, a considerable portion of the colon and numerous coils of the small intestines were found in the left chest cavity. There were numerous adhesions about the hernial ring of the diaphragm, but none to the lung or pleura. The left lung appeared to be entirely collapsed, and showed no sign of expanding during the operation. The opening in the diaphragm extended from about an inch lateral to the œsophageal hiatus, to within about an inch and a half of the costal attachment of the antero-lateral border of the diaphragm. In order to release the adhesions about the diaphragm and reduce the viscera, it was necessary to incise this small antero-lateral intact portion of the diaphragm, and extend our incision into the abdomen. After this we were able to release the adhesions fairly satisfactorily, and to reduce with ease



FIG. 3.—X-ray showing condition of chest in summer of 1928, eleven months after operation. The diaphragm on the left is seen to be intact. Beneath it is a gas bubble in the colon. Above, the lung is seen to be partially expanded, but does not extend out to chest wall. A comparison of the size of the right and left sides of the diaphragm, in this picture, shows the advantage gained by performing the preliminary extrapleural thoracoplasty.

all the abdominal viscera, except the spleen. This organ was attached to the margin and upper surface of the diaphragm so securely, and the veins in its pedicle were so numerous, thin and distended, that we were unable to free it. Consequently, we ligated the pedicle and removed the spleen. The only other possible course would have been to reduce the spleen and with it turn down a portion of the diaphram. This procedure would have exposed us to the too great chance of puncturing some of the varicose splenic veins when we sutured the diaphragm, and since we were working above the diaphragm, and the resultant hæmorrhage would have been concealed below the diaphragm, we decided the better policy would be to remove the spleen. With the stomach and intestines reduced and packed into the abdomen, and the spleen removed, the repair of the diaphragm became simple. We sutured it with a continuous chromic two catgut, overlapping the edges. We then put in another layer of interrupted linen sutures. An endeavor was

made to expand the lung with increased pressure from the gas-oxygen machine, but entirely without success. The wound was closed tight in layers, with chromic one and two catgut. Interrupted silkworm gut was used for stay sutures and skin sutures. The patient stood the operation well.

*Subsequent Course.*—The patient did well for a week following the operation. He accumulated some fluid in the left chest soon after the operation. We aspirated this on the fifth day and obtained a sterile, straw-colored fluid. Two days later, he developed a septic sore throat. His temperature ran 103–104. October 4 we transfused him. October 7 we aspirated his chest again and found a purulent fluid containing pneumococci. The next day we opened the incision enough to insert a stiff rubber tube and establish drainage. He was transfused again on October 15, and November 8. The tonsils continued to give trouble and remained large, inflamed and cryptic, so on November 30 tonsillectomy was performed by Dr. B. W. Fassett, under local anæsthesia. He began to improve. Luckily his appetite was stupendous. He consumed enormous amounts of food, which probably was his salvation. He had formed the habit of heavy and frequent eating before his operation, having found that as long as he could keep his stomach full the weight of the food would prevent, to considerable extent, the tendency for the stomach to creep up into his chest. This habit stood him in good stead, and kept his vitality up. He was discharged from the hospital December 24, after having been up and afebrile for ten days, but with a cavity in his chest that would hold a quart of irrigating fluid without difficulty. X-rays had shown his diaphragm holding well throughout this time. Upon discharge from the hospital he was instructed to stay in the sunshine on good days, to blow a trombone or anything else that would help expand his lung, and to irrigate the chest cavity

Fig. 4.—Picture of the patient eleven months after the first operation. He looks well nourished and healthy. The lower incision was the one used in obtaining the collapse of the chest wall, while the incision beginning beneath the scapula was made at the operation for the actual repair of the hernia. Just above the point where the two incisions cross is seen the site occupied by the drainage tube for eight months.

alternately with Dakin's solution (chlorazene) and neutral acriflavine. He reported back at two weeks' intervals for observation.

When he left the hospital, I expected to attempt a complete collapse of the left chest at a later date to cure the empyema, but hoped to get some lung expansion before doing that. We were pleased and surprised to find that the cavity diminished in size much more rapidly than we had even dared to hope. In the meantime, he went where he pleased, played, worked a little and appeared to suffer no inconvenience. The cavity gradually got to the place where it would hold no solution. June 11, 1928, we admitted him to the Rainey Hospital, removed his tube, X-rayed him and observed him for two

weeks. He was allowed to go where he pleased, reporting every four hours, however, to have his temperature taken. His temperature was normal throughout his stay. He was full of pep, looked robust and weighed one hundred and twenty-six pounds, which was eighteen pounds more than he weighed eleven months previously, upon his admission to the Watts Hospital for his first operation. Blood pressure was 96/60. Chest wound well healed. Breath sounds audible in left chest. The P. M. I. of the heart was in the fifth interspace, two and one-half inches from the mid-sternal line. Chest measurements:

Expiration, 28½ inches. Inspiration, 30 inches.

Right side: Expiration, 15¼ inches. Inspiration, 16¾ inches.

Left side: Expiration, 13¼ inches. Inspiration, 13¼ inches.

Thus he had one and one-half inches expansion, all of which occurred on the right side, the measurements being made at the level of the nipples.

October 14, 1928, he was seen again, and examined and found to be in excellent condition. He says that he is now as well as anybody. He weighs 138 lbs.—which is 30 lbs. more than he weighed before our first operation.

### CONCLUSIONS

Diaphragmatic herniæ that are too large for repair by other means, may be repaired by a two-stage operation, the first stage of which consists of a preliminary extrapleural thoracoplasty, involving the lower chest on the affected side. The second stage—the repair operation—may be done through either a thoracic, abdominal, or combined thoraco-abdominal incision. The case here reported was done through a thoraco-abdominal incision. The patient received a cure. It is interesting to note that he recovered from a post-operative empyema thoracis without approximating the visceral and parietal pleuræ.

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# THE NORMAL THICKNESS OF THE PYLORIC MUSCLE AND THE INFLUENCE ON IT OF ULCER, GASTRO-ENTEROSTOMY AND CARCINOMA*

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FROM THE MAYO CLINIC

WHEN gastro-enterostomy brings relief to a patient with peptic ulcer the result is so prompt that it is hard to conceive what the mechanism can be. One thinks first of a lowering of acidity and lessened irritation to exposed nerve endings, but in that case one would expect from Palmer's observations on healing ulcers to see the relief come more gradually. Furthermore, it would be hard to explain the prompt relief of symptoms often observed in persons who after operation do not get much reduction in acidity, or in persons who have a low acidity to begin with.

It would probably be easier to explain the sudden cessation of pain on the basis of prompt relaxation of the spasm in the pyloric muscle which almost certainly is present in many cases of ulcer.[9] Certainly when obstruction is present and the muscle throughout the pyloric segment is hypertrophied there can be little doubt about the existence of strain and overwork, and little question but that the shunting of the current through a new channel should bring immediate rest to the tissues about the pylorus and the ulcer.

There are reasons for believing also that with the entrance of food into the upper part of the jejunum, reverse ripples will run back up the duodenum to produce relaxation and inhibition of the cap and pyloric ring.[1] Such relaxation and cessation of function might well lead to atrophy of the muscle, and some observations by Truesdale suggest that this actually takes place. He found the pyloric muscle to be hypertrophied in fifteen cases in which the lower end of the stomach was removed for duodenal or gastric ulcer and atrophic in three cases in which resection was carried out some time after gastro-enterostomy. These observations were so few in number that we thought it best to reinvestigate the subject in more detail. To do this we measured the thickness of the pyloric muscle in 165 stomachs removed at necropsy and preserved in Kaiserling solution at The Mayo Clinic.

*Technic.*—A longitudinal cut was made through the anterior wall of the lower end of the stomach midway between the curvatures, and the pars pylorica, with mucous surface downward, was flattened on a piece of cork so that, with the knife held vertically, sections could be cut longitudinally through the region of the sphincter. In normal stomachs there was so little

variation in the thickness of these sections that measurement of one or two was sufficient, but when the pylorus was much deformed by previous ulceration it was necessary either to take the average of several measurements made in different parts of the ring or to discard the specimen. Most of the sections so discarded were from stomachs with gastro-enterostomy openings. In them the pylorus was often so twisted and the muscle so divided by scar tissue into thinned and thickened segments that no generalization could be made in regard to its width.

TABLE I

*Thickness of the Pyloric Muscle in Normal Subjects*

| Age, years | Sex | Embalmed | Height, cm. | Weight, kg. | Thickness, mm. | Estimated thickness* |
|---|---|---|---|---|---|---|
| 59 | M | + | 182 | 86 1 | 8 2 | 6 5 |
| 64 | M | + | 182 | 90 6 | 7 0 | 6 6 |
| 54 · | M | | 167 | 58 9 | 4 8 | 5 3 |
| 49 | M | + | 180 | 56 6 | 4 3 | 5 3 |
| 41 | M | + | 182 | 81 6 | 6 2 | 6 3 |
| 52 | F | + | 159 | 49 7 | 4 6 | 5 0 |
| 59 | M | + | 181 | 72 5 | 8 5 | 5 8 |
| 21 | M | + | 173 | 65.7 | 4 8 | 5 8 |
| 80 | M | + | 170 | 86 2 | 6 2 | 6 5 |
| 20 | M | + | 174 | 61 2 | 4 6 | 5 4 |
| 29 | F | + | 168 | 59 8 | 5 6 | 5 4 |
| 75 | F | | 147 | 74 8 | 4 4 | 6 0 |
| 63 | M | + | 177 | 68 0 | 4 4 | 5 7 |
| 32 | M | + | 180 | 61.2 | 3 8 | 5 4 |
| 56 | M | + | 177 | 61 2 | 6 9 | 5 4 |
| 72 | M | | 169 | 68 0 | 6 0 | 5 7 |
| 67 | F | | 159 | 68 0 | 5 7 | 5 7 |
| 69 | M | | 176 | 81 5 | 5 2 | 6 3 |
| 28 | F | + | 145 | 43 1 | 6 5 | 4 7 |
| 43 | M | + | 178 | 86 2 | 5 8 | 6 5 |
| 36 | M | | 156 | 68 0 | 4 8 | 5 7 |
| 68 | M | + | 178 | 95 2 | 8 4 | 6 9 |
| 73 | M | | 177 | 72 5 | 5 8 | 5 9 |
| 61 | F | + | 169 | 90 6 | 6 0 | 6 7 |
| 67 | M | + | 163 | 74 8 | 7 2 | 6 0 |
| 23 | F | + | 168 | 72 5 | 6 0 | 5 9 |
| 36 | M | | 187 | 90 6 | 5 0 | 6 6 |
| 55 | M | + | 157 | 63 4 | 5 8 | 5 5 |
| 61 | F | + | 155 | 74 8 | 5 4 | 6 0 |
| 48 | M | + | 178 | 63 4 | 5 0 | 5 5 |
| 54 | M | + | 170 | 81 6 | 7 0 | 6 2 |
| 83 | F | + | 170 | 72 5 | 6 6 | 5 9 |
| 41 | M | + | 184 | 83 8 | 5 6 | 6 3 |
| 55 | F | | 165 | 77 0 | 5 6 | 6 1 |
| 61 | M | | 169 | 54 4 | 5 2 | 5 2 |
| 60 · | M | + | 167 | 45 3 | 5 2 | 4 8 |
| 50 | F | | 166 | 90 6 | 6 0 | 6 7 |
| 50 | M | | 175 | 68 0 | 6 0 | 5 7 |
| 60 | F | + | 163 | 61 2 | 6 6 | 5 4 |
| 35 | M | | 180 | 81 6 | 6 4 | 6 3 |
| 48 | F | + | 168 | 74 8 | 7 4 | 6 0 |
| 23 | M | ? | 179 | 59 8 | 6 6 | 5 4 |
| 52 | F | | 168 | 77 0 | 6 7 | 6 1 |
| 17 | F | | 160 | 52 2 | 4 0 | 5 1 |
| 13 | M | | 157 | 40 7 | 4 8 | 4 6 |
| 15 | M | | 166 | 34 0 | 4 6 | 4 3 |
| 19 | F | | 170 | 34 0 | 5 8 | 4 3 |

* According to weight of the subject. See text.

CHILDREN

| | | | | | | |
|---|---|---|---|---|---|---|
| 7...... | M | + | 107 | 27.2 | 3.4 | |
| 6...... | M | + | 119 | 27.2 | 3.4 | |
| 6...... | F | | 116 | 22.6 | 4.8 | |
| 2...... | M | + | 95 | 13.6 | 3.6 | |
| 8...... | F | + | 118 | 34.0 | 4.2 | |
| 1...... | M | | 69 | 9.1 | 2.6 | |

OVERWEIGHT PERSONS

| | | | | | | |
|---|---|---|---|---|---|---|
| 48...... | M | + | 177 | 113.4 | 6.0 | |
| 63...... | F | | 170 | 136.0 | 5.0 | |

Most of the measurements were taken from the enlarged image of the muscle as it was projected from a microscope onto a screen, but in a few cases they were made directly from the section with the help of a binocular loupe and a pair of dividers. In order to avoid the possibility of mental bias, the measurer, at this stage of the work, kept himself in ignorance of the origin of the specimen in hand.

*Normal Thickness.*—For normal controls we measured the thickness of the pyloric muscle in fifty-five stomachs in cases in which there had not been any sign of disease in the upper part of the digestive tract. The original figures are given in Table I. Little use was made of the measurements on the five children from two to eight years of age because such ages are not represented in our groups of patients with diseased stomachs. We excluded also from representation in Figure 1 the two cases in which the subjects weighed more than 113 kg. The interesting point about them is that their pyloric rings were not thicker than normal for persons of average weight.

In view of the fact that some of the subjects were young, some old, some short, some tall, some thin, and some fat, we first looked for correlations between thickness of pyloric muscle and age, height, and weight. We expected to find some because Scammon [5, 6] and others have found a relation between the age of the subject and the weight and capacity of the stomach. Actually when we included all the data from children as well as adults we obtained good correlation coefficients. The best, $+ 0.68 \pm 0.05$, was for thickness of pyloric muscle and weight of body; next was $+ 0.60 \pm 0.06$ for thickness of muscle and height; and last was $+ 0.53 \pm 0.06$ for thickness of muscle and age. In later years after growth stops and height and weight are not so closely dependent on age, these correlations are not so marked, and (with our data) the respective coefficients drop to $+ 0.46 \pm 0.08$, $+ 0.28 \pm 0.09$, and $+ 0.36 \pm 0.08$.

Using the method of partial correlation which enables one to calculate the degree of relationship between two variables while another is held constant, we gained the impression that in adults there is little real correlation between height and thickness of the pylorus, and that the fair degree of correlation with weight is dependent partly on the correlation between weight and age.

It was a question in some cases whether to use in our calculations the normal weight of the patient or the often diminished weight at the time of death; arguments might be advanced in favor of either practice but we used the weight of the body at necropsy.

On account of difficulties in cutting the sections perpendicularly to the surfaces of the tissue and in knowing just where to measure, we feared at first that our figures would have little value, but as we worked with them and found how well they were correlated with body weight and age, we put more trust in them. Almost certainly deductions may be drawn when, as in Figure 1, the mode or the whole distribution shifts to right or left. Small differences in the means are not so trustworthy and they could be accepted only after corrections had been made for differences in the composition of the groups. Because the thickness of the pylorus varies with the weight and age of the subject it would be unwise to compare averages in two groups of, let us say, normal and ulcer-bearing persons unless the percentages of thin and fat and young and old were nearly the same in those groups. One would either have to choose a control group with ages and builds comparable to those of the diseased persons or, what is often more feasible, one could correct the mean of the diseased group by multiplying by a computed factor. The arithmetic of the process has been described elsewhere by Alvarez and Zimmermann. In addition to the corrections already mentioned we had to correct for differences due to the embalming of some bodies and not of others. This was important because in twenty-seven normal persons embalmed before necropsy the pylorus averaged 6.0 ± 0.2 mm. in thickness, and in thirteen not embalmed it averaged 5.5 ± 0.1 mm.

More trustworthy and instructive than corrected means, however, are polygons such as are shown in Figure 1. The first ones made, representing the distributions of the actual measurements obtained in the several groups of normal and diseased stomachs, looked much like those in Figure 1. In the forty-seven normal stomachs the mode or most common measurement was 6 mm.; about the same as the mean which was 5.8 ± 0.2 mm. The range was from 3.8 to 8.5 mm.

The simple type of frequency distribution apparently gave fairly trustworthy information, but because variations of 2 mm. or more in pyloric thickness are commonly due to differences in body size and in the mode of fixation of the tissues, it seemed best to express each measurement in terms of its deviation (in millimeters) from the estimated normal. The normal was calculated from a formula, $P.t. = 0.0415 \times W + 2.9$ (derived from our data on embalmed bodies), in which $P.t.$ represents thickness of pyloric muscle in millimeters and $W$ represents weight of the body in kilograms. When the body had not been embalmed 0.5 mm. was subtracted from the estimate.
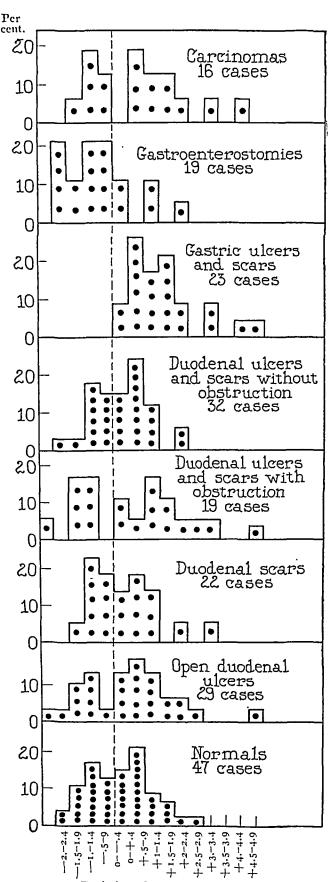
*Duodenal Ulcer.*—When all cases of "duodenal ulcer," open and healed, were put together, the polygon was found to be somewhat bimodal as it would be if there were two types of ulcer, one producing slight atrophy and the other some hypertrophy of the muscle. This division into two groups was found

to be even more marked when the twenty-nine open and chronic ulcers were charted alone. The measurements from cases of healed ulcer were almost all within the limits of normal. One very thick pyloric muscle was found in a case of syphilis and cirrhosis of the liver; the stomach was much dilated but otherwise there was little evidence of obstruction.

It seemed probable that the presence or absence of obstruction would have an important influence on the thickness of the pylorus so the cases were divided into two groups; one with definite or fairly definite pyloric obstruction and · the other in which evidence of it could not be found in any part of the record. As we expected, there was more hypertrophy in cases of obstruction, but the difference was not striking, and one of the thinnest pyloric rings seen was obtained from a stomach in which there had been obstruction.

In twenty-two of the cases gastro-enterostomy had been performed from one to eighteen days before death, but this procedure so far as we could see, in the short interval of time, did not have any effect on the muscle, and the distribution polygon of these cases was the same as that of the open ulcers.

*Gastric Ulcer.*—The next distribution in Figure 1 represents measurements from twenty-three cases of gastric ulcer and combined gastric and duodenal



Deviations from normal in mm.
FIG. 1.—Thickness of the pyloric muscle in health and disease. Histograms representing percentage distributions of cases in terms of deviations from the normal mean (estimated according to weight of the subject by formula given in text). The dotted line represents the normal mean.

ulcer. It was hard to know how to classify some of these cases, because in eleven there was ulceration also below the pylorus and in a few the duodenal lesion was the larger and apparently more important one, but we finally decided to put all cases with any gastric ulceration into this group.

It will be seen that in every case the measurements were above the average and in several cases hypertrophy was marked. Apparently, then, there is a decided difference in the way in which the pyloric muscle responds to ulceration above and below the sphincter, a difference due perhaps to the existence of a connective tissue barrier between the stomach and the duodenum.[3] The muscle fibers that make up the sphincter, being more or less continuous with those that surround the pars pylorica, would be more subject to stimulation by ulcers in the lower end of the stomach than by ulcers in the somewhat separate and distinct duodenum.

In twelve cases in which the gastric ulcer or ulcers were situated some distance from the pylorus there were only four with pyloric muscles from 2.0 to 3.2 mm. thicker than normal, and in three of these there was ulceration in the duodenum as well as in the stomach. In eight cases in which the gastric ulcer or ulcers were at or near the pylorus there were two with muscles more than 2 mm. thicker than normal. One, 4.0 mm. thicker than normal, was associated with a very small scar that had produced much narrowing of the pylorus; the other, 4.5 mm. thicker than normal, was associated with an old healed gastric ulcer and a chronic puckering duodenal ulcer. In three cases it was hard to classify the site of the ulcers. Most of the gastric lesions appeared to have been open ulcers. In the nine cases in which obstruction is mentioned or indicated in the record there were two with marked hypertrophy of the muscle, three or four with moderate hypertrophy, and three with muscles within 1 mm. of normal. As has been noted, the two most extreme degrees of hypertrophy were seen in cases of healed ulcers.

*Gastro-enterostomy.*—The next distribution in Figure 1 represents measurements from nineteen stomachs in which a gastro-enterostomy opening had existed for some time. In one case the interval between operation and necropsy was a month, in another it was two years, in another, three years, and in the remainder it varied between five and seventeen years. In twelve the operation was performed for fairly definite duodenal ulcer and in four for "pyloric" ulcer. In one there probably had been both duodenal and gastric ulcers but the scars were faint; in two there were no scars at all and there were other reasons for suspecting that the gastro-enterostomy had been performed without sufficient cause. In four cases death followed an operative attempt to deal with a gastrojejunocolic fistula, and in one case the patient died of inanition produced by such a fistula. In this case both the duodenal and gastrojejunal ulcers were healed and the pyloric muscle was extremely thin. Another very thin muscle was found in one of the cases in which gastro-enterostomy was performed probably without sufficient cause. Even

in the few instances in which, at necropsy, there was still definite obstruction at the pylorus the muscle was thinner than normal.

In the case in which operation had been performed one month before death the duodenal ulcer, which had given symptoms for fourteen years, was undergoing healing and there was a small acute gastric ulcer near the gastro-enterostomy suture line. The pyloric muscle was 1.7 mm. thinner than the average for a man of 75 kg. In all the other cases the ulcers were healed.

From the appearance of the distribution polygon there would seem to be little doubt that the pyloric muscle tends to become thinned after gastro-enterostomy. In fifteen cases the measurements were below the average.

*Carcinoma of the Stomach.*—Having in mind the possibility that hypertrophy of the pyloric muscle might be due not only to overwork but to alterations in metabolic rate brought about by adjacent ulceration and inflammation, we studied the effect of carcinoma in the lower end of the stomach. Cases were chosen in which the growth extended almost, but not quite, to the pyloric sphincter. In a few it extended down under the serous coat but care was taken to exclude all those in which an increase in the thickness of the muscle was due to the intrusion of foreign cells.

The last distribution in Figure 1 shows that in two or three cases there was hypertrophy but in the remainder the measurements were within the limits of normal. When the outlet of the stomach is narrowed, made rigid, or blocked by cancer cells one would not expect the strain on the muscle to be so great as it is when a benign, spasm-producing ulcer is present, so it may be that hypertrophy is due sometimes not to overwork but to an abundance of those stimulating tissue-juices described by Burrows and Carrel; juices which may account also for the noncancerous enlargement so often seen in some of the glands situated near carcinomas of the stomach.

## COMMENT

The thesis with which we started has received considerable support and it now seems clear that in gastro-enterostomized stomachs, the pyloric muscle tends to be thinner than normal. The fact that in most of those persons with scars in the duodenum the thickness of the pyloric muscle was within the limits of normal suggests that when the muscle atrophies after gastro-enterostomy it does so not simply because the ulcer has healed but because the mechanics of the region are in some way changed.

Strange to say, gastro-enterostomy in infants with congenital pyloric stenosis does not appear to have any effect on the muscular tumor.[4, 10] Perhaps the muscle in these cases is metabolically different from that in the remainder of the stomach so that it can stand out independently much as lipomas do in a person who has lost much body fat.

## SUMMARY

In forty-seven adults without gastroduodenal disease the pyloric muscle varied in thickness from 3.8 to 8.5 mm., with an average of 5.8±0.1 mm.

The measurements varied with the weight, height and age of the subject and with the type of fixation (embalming fluid or Kaiserling solution) used.

In the absence of obstruction, duodenal ulcer seems ordinarily to have little influence on the thickness of the pyloric muscle. Occasionally it appears to produce atrophy, and when obstruction is present there sometimes is hypertrophy. Gastric ulcer generally produces hypertrophy.

Gastro-enterostomy tends to produce atrophy of the pyloric muscle. Carcinoma in the pars pylorica ordinarily has little effect, but occasionally it is associated with hypertrophy of the muscle.

These observations lend support to the thesis that the prompt relief of pain after gastro-enterostomy is due at least in part to the immediate removal of strain and overwork from the muscle in the pyloric region.

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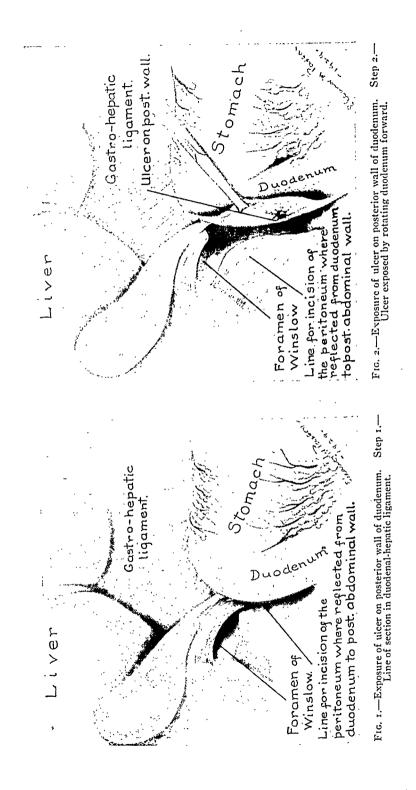
# PERFORATED PEPTIC ULCER*

## By John B. Deaver, M.D.

of Philadelphia, Pa.

Peptic ulcer is a serious condition, not only because of the suffering and disability it entails, but because of its inherent grave possibilities, such as hæmorrhage and particularly perforation. Emphasis is brought to bear upon this statement by the fact that practically 20 per cent. of ulcers perforate. Inasmuch as there is no way of telling which ulcer will and which will not perforate or bleed, it is no exaggeration to say that every chronic peptic ulcer is potentially a perforated or a bleeding ulcer. Perforation, unless seen early and operated upon early, carries a high mortality. There would be little more for me to say upon this subject than to plead for serious attention to a peptic ulcer syndrome, were it not for the well-known fact that in a certain number of perforating cases the perforation is the first definite indication of the presence of ulcer, just as hæmorrhage, in many instances, is the first indication of ulcer. This, however, is not the rule, in fact fully 90 per cent. of cases have a previous ulcer history, so that the diagnosis of peptic ulcer is of vital importance. The typical history, as outlined by Moynihan about twenty-five years ago, still holds good, although the addition of various tests and such adjuncts as the fluoroscope and the röntgen plate have, to some extent, made for more certainty of diagnosis, especially when the history is vague and not altogether typical. At the same time, it is my experience, and I have no doubt also the experience of many of you, that röntgen-ray diagnosis is not always reliable, that is to say, a negative report cannot be taken as a positive indication of the absence of ulcer. Time and again I operate in such instances to find the most beautiful example of ulcer presenting itself to view. Contrariwise, I occasionally get a report: "deformity of the duodenal cap, indicative of ulcer", and at operation find no ulcer, but a pericholecystitis or frank cholecystitis.

In the perforating case, however, no such uncertainty exists as a rule. That is to say the diagnosis is comparatively easy that an abdominal crisis exists; the crux of the matter lies in early treatment. The value of early surgery has so often been stressed and demonstrated by the favorable figures as far as mortality is concerned, that I need not run the risk of boring you with additional proof. Get them early and you'll get them well, is as valid a slogan today as it ever was. This means, as you well know, getting them before the poison of peritonitis gets a chance to do its deadly work. Nevertheless there are still some who fail to recognize the importance of this and who postpone seeking surgical advice until after the onset of peritonitis, which means, of course, added risk. On the whole, however, I may say that con-

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Fig. 1.—Exposure of ulcer on posterior wall of duodenum. Step 1.— Line of section in duodenal-hepatic ligament.

Fig. 2.—Exposure of ulcer on posterior wall of duodenum. Step 2.— Ulcer exposed by rotating duodenum forward.

stant hammering and pleading for early surgery by myself and others like me, who are willing to brave boring the profession by constant repetition, has been effective to some degree. But we must not let up on the propaganda. There are always newcomers in the field who need to be impressed with the importance of this subject.

The onset of perforation is dramatic in its suddenness. It affects the entire abdomen which at once becomes absolutely rigid. The patient is prostrated, although not shocked in the strictly surgical sense of the word. This
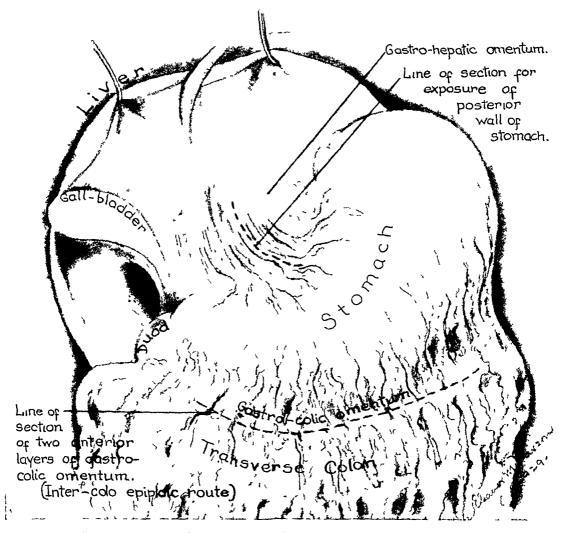


Fig 3 —Exposure of posterior wall of stomach   Step 1 —Line of section

comes later with the onset of peritonitis, which is avoidable and can be forestalled. One reason why some medical men fail to recognize perforative ulcer is because in the very early stage the pulse rate is practically normal. Nevertheless, the severe prostration together with the excruciating pain, board-like rigidity, and the characteristic short costal respirations as the patient keeps his legs flexed and the body fixed with the hope of easing the pain and protecting the abdomen from examination or contact, these should certainly be sufficient to make the diagnosis. The other signs and symptoms appearing later are vomiting, occasional absence of liver dulness, sometimes

hiccough, shifting abdominal dulness indicative of fluid, followed by cold and clammy skin and finally death, unless the last-named catastrophe is prevented by early operation.

In the face of such a crisis, the thing is to recognize the demand for immediate surgery. This is of much greater importance than to be able to tell whether the crisis is caused by a gastric or a duodenal ulcer, an appendix, a gall-bladder, or a pancreatic hæmorrhage. The abdominal incision will reveal the truth. At the same time there is an advantage and certainly a great satis-
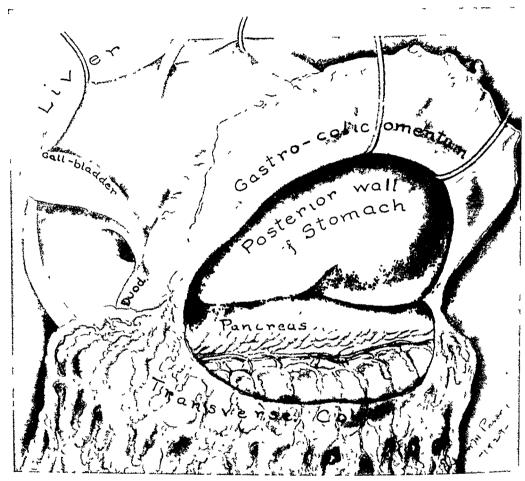


FIG 4—Exposure of posterior wall of stomach  Step 2—Posterior wall of stomach exposed

faction in being able to differentiate between an acute perforation and an acute pancreatitis. A few words to make this clear may, therefore, be in place. As I have often said, the reason the differentiation is not made more often is the failure to think of the pancreas.

In acute pancreatitis the pain is more excruciating and prostrating than in perforation, and vomiting is repeated, so that intestinal obstruction may be thought of. The difference, however, is that the vomitus consists of gastric or duodenal contents; in addition, the face is livid, and bluish patches of cyanosis may appear over the abdomen and limbs. Halsted was the first to call attention to this cyanosis which he found to occur only in acute pancrea-

titis, although not in every case of that disease—a point to be remembered when examining the abdomen. The rigidity is less marked and is limited to the upper part of the abdomen which is more prominent than elsewhere; tenderness, however, involves the entire abdomen, but is more acute in the upper part and more marked on the left than on the right side.

Once in the hands of the surgeon, what had best be done for the victim of a perforating ulcer? I would say that if the lesion be gastric, I would not, as a rule, deem it wise to excise the ulcer. It not only consumes time but presents the added disadvantage of having a larger opening to close, and entails the risk of dividing large vessels with the attendant danger of hæmorrhage. I prefer to suture the hole through the seromuscular coats, without freshening the edges of the perforation. If, however, this procedure is not feasible, I close the opening either by suturing a tag of omentum over it, or by anchoring the gastrohepatic omentum down to the perforation. If drainage be required, which it seldom is, a piece of rubber dam is placed down to the site of the sutured perforation and a tube is introduced into the pelvis through a stab wound above the pubic bone. In perforated gastric ulcer, in addition to closing the perforation, I make a gastro-enterostomy. In the very late cases where smear and inspection show a virulent peritonitis, I only close the perforation. I always have maintained and still do maintain that a gastro-enterostomy in the absence of peritonitis is a logical and safe procedure, accomplishing both immediate and remote good. Until recently this also was my practice in the treatment of perforated duodenal ulcer. For about two years now, I have been only closing the perforation and in addition have made a wide removal of the anterior half of the pyloric sphincter muscle. Whether the latter can be safely done depends upon the site of the perforation. If the perforation be close to the pylorus, I still make a posterior gastro-enterostomy, except in the very late cases. I find that in the early case the abdominal fluid is sterile, as proven by smears taken and examined as soon as the abdomen is opened, so that there is no contraindication to doing the gastro-enterostomy. It is my practice to smear all acute abdominal cases. The bacteriologist and pathologist are constant companions in the operating theatre. Posterior gastro-enterostomy is particularly indicated where, because of friability of the duodenum, the perforation cannot be satisfactorily closed so that leakage may occur; the anastomosis also relieves tension of the sutures and thus reduces the chance of future ulcer.

The perforated peptic ulcer is occasionally difficult to locate. This applies especially to gastric ulcer on the posterior wall of the stomach in communication with the lesser peritoneal cavity, and to duodenal ulcer on the posterolateral or the posterior wall. An ulcer on the posterior gastric wall that has perforated into the pancreas and has caused a superficial necrosis is more difficult to deal with than the posterior wall ulcer in communication with the lesser peritoneal cavity. Perforated ulcer of the lesser curvature or of the posterior wall close to the lesser curvature is not difficult to handle. The escaping fluid from either is the best indication

of perforation. However, if the perforation be small and there be much exudate that has invaded and bound together contiguous tissues, a careful dissection is required to disclose the walls of the viscus, the site of the pathological opening. To assure a perfect closure, outside of the choice of the anæsthetic, I consider the clear exposure of the site of the leak and of the serosa immediately surrounding it, absolutely necessary for a promising outcome.

Perforated ulcer of the anterior wall of the stomach is very easy to close. Perforated marginal ulcer, if not on the gastro-jejunal margin, can usually be closed without cutting out the anastomosis.

The approach to an ulcer of the lesser curvature or the posterior wall is most satisfactorily made through the lesser or gastrohepatic omentum, while for the ulcer on the posterior wall distant to the lesser curvature and adherent to the pancreas, the approach is best made through the intercolo-epiploic route. This enables one thoroughly to expose the posterior wall. The perforation can then be closed, the necrotic surface of the pancreas cauterized, and a small portion of the great omentum interposed between the affected portion of the pancreas and the site of the closed ulcer. One or more catgut sutures carried superficially through the surface of the pancreas and the omentum will retain the latter.

As I have stated, it was formerly my practice to complete the operation in both duodenal and gastric perforation by a posterior gastro-enterostomy. Recently, however, while I make a posterior gastro-enterostomy in the gastric perforation, I do not, with few exceptions, do so in the duodenal perforation. Making a gastro-enterostomy in perforated duodenal ulcer depends upon the size of the perforation and its distance from the pylorus. Where it is far enough away to allow a generous removal of the entire anterior half of the pyloric sphincter muscle after closure of the perforation, I make the muscle dissection. This dissection is carried half an inch beyond the pylorus on the gastric side and slightly less than this on the duodenal side. The cases I have operated in this manner have made smooth recoveries and are perfectly well, up to the present.

# ACUTE INFLAMMATION OF MECKEL'S DIVERTICULUM

## By William L. Wolfson, M.D.

### AND

## Benjamin Kaufman, M.D.

### OF Brooklyn, N. Y.

Meckel's diverticula with acute inflammatory changes have been operated upon by the writers four times within a period of seven months (June to December, 1927). An acute abdominal condition so striking and unusual, observed with such frequency, in this brief time, has served to emphasize certain diagnostic criteria by which we were able in the fourth and last case to predict before operation the existence of an acute perforative lesion of Meckel's diverticulum.

The literature abounds with curious instances concerning this congenital structure, its anomalies of position, size, form and histo-pathology, and its relation to other abdominal viscera. The inconsistencies it presents make the pre-operative diagnosis of an involved Meckel's diverticulum perplexing and difficult.

CASE I.—A boy, aged eight, was admitted to the United Israel-Zion Hospital, June 19, 1927. Three days prior to admission he had sudden and generalized colicky pains in the abdomen. He vomited several times that day and each day thereafter. The abdominal pains recurred at irregular intervals throughout this period, becoming more marked in the right lower quadrant by the late afternoon of the second day. The temperature then noted was 103° F., falling to 102.4° F. the following day. Under the influence of cathartics there were free bowel evacuations the first and second days, none thereafter.

*Physical Examination.*—A thin child, with anxious face, evidently very ill and in acute pain, with thighs drawn upon abdomen and legs flexed on thighs. The abdomen was greatly distended and tympanitic. There was some dulness in the right lower quadrant and slight rigidity that was most marked in that area close to the umbilicus. Peritoneal tenderness was present over the lower half of the abdomen, elicited best on the right side just below the umbilical level. Temperature, 99.6° F. Pulse 128. Total number of white blood cells 20,600; polymorphonuclear leucocytes 85 per cent.; lymphocytes 17 per cent.

The pre-operative diagnosis was acute appendicitis.

*Operation.*—A right McBurney incision. A moderate amount of serosanguineous fluid was found within the peritoneal cavity. The appendix was normal. The ileum in the right lower quadrant was distended and bluish-red. Two feet proximal to the ileo-cecal area there was disclosed an acutely inflamed Meckel's diverticulum extending across the midline toward the left and upward. It was six inches long, half an inch wide and had no mesentery. There was a small perforation a half inch from the distal end. The tip was intimately attached to a part of the mesentery of the small intestine on the left. Diverticulectomy and stump inversion with peritonealization was the operative procedure. A Penrose drain was placed through the abdominal wound. Recovery took place after a stormy convalescence.

CASE II.—A man, aged twenty-nine, entered the United Israel-Zion Hospital, August 28, 1927. During the night of August 26, 1927, he was awakened from sleep by severe pain in the epigastrium which soon became generalized and recurred at varying intervals. The localization of pain was indefinite, but centred mainly about the umbilicus.

Decided nausea was present at times, but there was no vomiting. There was diarrhœa, probably by the use of a cathartic.

When admitted he was suffering moderate abdominal, colicky pains; not acutely ill. The abdomen was tense and much distended. Tenderness was elicited in the right lower quadrant, close to the median line and immediately below the umbilicus. The temperature was 102° F. Total white blood count 9,850; polymorphonuclear leucocytes 84 per cent.; lymphocytes 16 per cent.

The pre-operative diagnosis was acute appendicitis.

*Operation and Operative Findings.*—Under a right McBurney incision, a long, kinked, but otherwise normal appendix was viewed. Toward the median line was felt a distended loop of small gut, which was pulled into the wound. On this loop and twenty inches from the appendix was a thin-walled diverticulum, two and one-half inches long, distended and bluish-black. The base was as wide as the diameter of the ileal loop from which it was derived (about one and one-quarter inches), the top rounded and lightly attached to a nearby portion of ileum with recent adhesions. This diverticulum had no mesentery. The operation was diverticulectomy, the stump infolded and peritonealized with great care on account of its large size. No drainage.
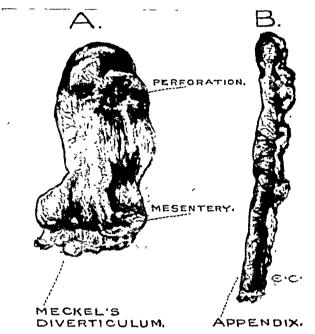


FIG. 1.—Case 3. (A) Meckel's diverticulum, thumb-shaped, with acute inflammation and perforation near the tip. A distinct and thick mesentery is present. (B) Appendix, same patient. (Reproduced black and white.)

*Pathological Report.*—Acute phlegmonous inflammation of Meckel's diverticulum. Uneventful recovery.

CASE III. A boy, aged nine, was admitted to the Jewish Hospital of Brooklyn, September 11, 1927. During the preceding day he had severe abdominal cramps accompanied by nausea and repeated vomiting. A laxative was taken. Within a few hours the cramps recurred.

An enæma was given and a thin watery stool was returned. The temperature was 98.2° F. that evening. The patient had a bowel movement during the night, but its appearance was not noted. Three hours before entrance to the hospital the temperature was 101.2° F., and upon admission had risen to 102.5° F. Pulse 135.

He was a well developed boy with flushed face, acutely ill. There was spasticity and acute tenderness in the right lower quadrant extending toward the midline of the abdomen and close to the umbilicus. Abdominal rebound tenderness was marked. Total white blood count was 20,800; polymorphonuclears 92 per cent.; lymphocytes 8 per cent.

The pre-operative diagnosis was acute appendicitis with diffuse peritonitis, the appendix probably situated near the midline of the abdomen.

*Operation.*—Through a right McBurney incision, the peritoneal cavity was entered; a grayish gelatinous fluid escaped; located in the right iliac fossa, close to the midline, was an acute gangrenous, perforated Meckel's diverticulum. This was thumb-shaped and unattached, three inches long and one and one-half inches wide at the base, where a thick mesentery with a large blood vessel was noted (Fig. 1 A). There was a large

perforation at its distal third. Diverticulectomy with stump inversion was performed. The appendix, being somewhat thickened, was removed, (Fig. 1 B). One cigaret drain was inserted to the pelvis. Recovery uneventful.

CASE IV.—A boy, aged ten, was admitted to the United Israel-Zion Hospital, November 30, 1927. The acute attack began one day before admission with vomiting and a "stomach ache" around the umbilicus. The vomiting recurred six times that day, but the intense pain decreased in severity. The next day the patient vomited three times. The abdominal pain was moderate and only occasional. After admission, the pain reappeared, but was then most marked in the left upper quadrant. Temperature was 102.2° F. The pulse was 120.

When admitted he seemed acutely ill. The abdomen was distended and slightly rigid. Definite tenderness, especially on rebound, was elicited over the entire abdomen, though less marked in the right lower quadrant. The maximum point of tenderness was one-half inch to the left and immediately below the umbilicus. Total white blood count was 20,200; polymorphonuclear leucocytes 88 per cent.; lymphocytes 12 per cent.

The pre-operative diagnosis was perforated Meckel's diverticulum.

*Operation.*—A midline and infra-umbilical incision was made. Free pus was evacuated from the peritoneal cavity. Below the umbilicus lay a nipple-shaped Meckel's diverticulum, three-quarters of an inch long, thick-walled, acutely inflamed and with a perforation near the tip. The diverticulum pointed to the left and was about two feet from the ileo-cecal valve. A distinct mesentery had to be ligated before diverticulectomy could be accomplished. The appendix was not disturbed. One rubber drain to the pelvis.

*Pathological Report.*—Phlegmonous inflammation of Meckel's diverticulum. Recovery uneventful.

Meckel's diverticulum is an occasional sacculation or cecal appendage of the ileum.[1] It is most commonly found in males[2] with an average age of about twenty-two, although it has been noted in infants. In our series of males the ages were eight, nine, ten and twenty-nine.

The incidence of Meckel's diverticulum is low, estimated by Harbin[3] at two per cent. Balfour found only fifteen cases in 10,000 consecutive laparotomies.[4] In 14,000 laparotomies McGlannan[5] encountered three cases. Coleman[6] had 1.8 per cent. in his series. Mitchell, of Chicago, out of 1635 autopsies, reported thirty-nine cases or 2.25 per cent. Adami in all his records gives the incidence as 2.7 per cent.[7] At the Boston City Hospital, in 1,382 autopsies, eleven cases were discovered. Fifteen cases out of 2,600 necropsies were shown at Johns Hopkins Hospital. From 8,133 necropsies at the Dresden City Hospital, only eight cases were recorded.[8]

At the seventh week of fetal development, the mid-gut becomes completely closed off from the umbilical vesicle (yolk sac) by the atrophy of the connecting yolk stalk. The point of final closure of the mid-gut represents a level on the future ileum about two and one-half inches to three feet above the ileo-colic junction. In approximately 2 per cent. of all individuals the intra-abdominal portion of the yolk stalk fails to disappear in a variable degree. This persistent remnant, an intestinal tubular appendage, is known as Meckel's diverticulum.[9]

Meckel's diverticulum is classified as *congenital* and *acquired,* or complete and incomplete. The congenital type is due to a non-obliteration of the fetal vitelline duct. The acquired form results from an original point of

lowered resistance or weakened intestinal wall. This usually occurs along the line of the mesenteric attachment of the intestine, where the vessels pierce the bowel wall and carry therein a sheath of fat. In the complete form of Meckel's diverticulum the sac is formed of all the layers of the intestinal wall. In the incomplete or false diverticula, the sac is formed of mucosa, submucosa and serosa, and it is in reality a hernia mucosæ through a weak point in the muscularis. Though the usual length varies from one-half to four inches, the diverticulum may exist as a nipple-like protrusion or reach a length of thirty-three and one-half inches, as has been reported by Moll.[10] The shape and contour may be tubular, blunt, spherical or pedunculated. The wall is the same as that of the intestine from which it develops. It may contain Lieberkuhn's glands and Peyer's patches. Some writers have reported secreting glands of the gastric type in the distal mucosa, whereas the proximal mucosa contained alkaline secreting glands of intestinal origin.[11]

Ulcer of the duct may occur, and, according to Stulz and Woringer,[12] is due to the presence in the affected diverticula of more or less extensive areas of gastroduodenal mucosa with fundal, pyloric and Brunner's glands. Heteroplasia of the gastric mucosa has been found in about twelve per cent. of cases reported. The histologic picture of diverticular ulcer is that of a gastric or duodenal ulcer or, better still, that of peptic ulcer of jejunum, following gastro-enterostomy (Hubschman). Stulz and Woringer conclude "That the diverticular ulcer is a peptic ulcer of an acute evolution, opening vessels penetrating into neighboring organs, and finally making its way towards the free peritoneum, eventually perforating and producing local or general peritonitis."

The lumen of the duct is usually the same diameter as the ileal gut, but occasionally the outlet is so narrowed as to possess a valve-like action; if entirely closed, a cyst may result. Foreign bodies such as fruit seeds are sometimes found therein.[13] The attachment of the duct is usually opposite the mesentery, but may be at right angles or in its fold. The duct rarely has its own mesentery, though distinct ones were found in two of our cases. The distal end may adhere to any part of the abdominal cavity or neighboring viscera, the most frequent points of attachment being the mesentery, umbilicus, small intestine and abdominal wall. Occasionally, fusion with the mesentery, provides a loop under which the small intestine becomes strangulated. Sometimes it narrows into a fibrous cord which may undergo torsion. The distal end may invaginate into the intestine to produce obstruction; or the duct may remain patent throughout with a resultant fistulous tract leading to the umbilicus (umbilical anus), excreting mucus and occasionally intestinal contents. Meckel's diverticulum may undergo the same pathologic changes as the appendix.

*Symptomatology and Diagnosis.*—The onset of Meckel's diverticulitis is usually sudden. The clinical course resembles that of an acute inflammatory or perforative lesion of a hollow abdominal viscus, plus partial obstruction of

the bowel. There is no outstanding symptom or sign pointing to a positive diagnosis, but a careful estimation of the more or less constant phenomena may direct attention to Meckel's diverticulum as the possible offending structure. Pain is early, colicky, recurrent and severe. It is generalized about the umbilicus until late changes cause secondary influences in the peritoneal cavity, such as peritonitis, perforation and obstruction. Vomiting is fairly persistent, recurring several times a day. This may be explained by the diverticulum's attachment, recent or old, to nearby structures, thereby involving or ensnaring the intestine to produce partial or complete obstruction. In one of our earlier cases in 1916, a child aged two, the involved diverticulum was attached to the appendix, arching and binding a section of the ileum, so as to cause a complete intestinal block. Distention is prominent and appears fairly early. It is generally widespread, but most evident in the lower half of the abdomen. The marked distention observed in our cases was out of proportion to the tenderness and rigidity, comparing the relative intensity of these signs to other instances of early peritonitis. The localization of tenderness and rigidity in Meckel's diverticulitis is fairly high up in the lower abdomen, usually about one-half inch below the umbilicus to the right or left. Temperature is marked by its high range. A most usual reading is 102° F. to 103° F. The general appearance of these patients indicates a greater toxemia than is usually observed in most early inflammatory lesions: *e.g.* acute appendicitis.

The pre-operative diagnosis of Meckel's diverticulum is rarely made. It was correct in the last of our series of four. Harbin recorded one pre-operative diagnosis out of a series of thirteen. The most frequent abdominal lesion to be differentiated is an acute appendix lying toward the midline, crossing it and extending to the left side. The more frequent pathologic conditions to be considered and excluded are:

1. Perforation of ileum due to foreign bodies. 2. Littré's hernia with obstruction. 3. Involved epiploicae, torsion or inflammation. 4. Diverticulitis of the sigmoid. 5. Acute salpingitis. 6. Primary peritonitis, pneumococcus. The possibility of intussusception must not be overlooked when symptoms of obstruction occur in very young children.

*Treatment.*—The procedure is diverticulectomy and inversion of the stump with peritonealization. Avoid narrowing and obstructing the lumen of the ileum. When perforation and peritonitis have occurred, the treatment is that of the latter condition. In advanced toxemia or delayed obstruction it is advisable to drain the ileum above the lesion by an enterostomy or by drainage through the base of the resected diverticulum.

## SUMMARY

Four patients, males, with Meckel's diverticulitis were operated within seven months; all recovered.

Pre-operative diagnosis was made in one instance based on the repeated or persistent colicky pains centred about the umbilicus, recurrent vomiting,

high temperature, toxicity and distention. The distention was out of proportion to the tenderness and rigidity as observed in acute and early peritonitis. Attention was directed to the signs and symptoms of an inflamed abdominal viscus, plus early and partial obstruction.

In acute abdominal disturbances, when the pre-operative diagnosis is not confirmed at operation, the terminal ileum should be explored for a Meckel's diverticulum.

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# THE MORTALITY OF INTESTINAL OBSTRUCTION*

ANALYSIS OF 124 CASES OPERATED UPON AT THE HOSPITAL OF THE
UNIVERSITY OF PENNSYLVANIA

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THE mortality following operation for intestinal obstruction seems abnormally high. There is a wealth of literature on this subject, but three papers may be quoted to prove the above statement. In 1888 Fitz,[1] of Boston, reviewed the English, French, and German literature from 1880 to 1888 and collected 295 cases, of which 146 were operated on. The surgical mortality was 70 per cent. In 1900 Gibson,[2] of New York, collected 1000 operations with a mortality of 43.2 per cent., a marked improvement, but in 1925 Van Beuren and Smith[3] found 1089 cases published since 1900 giving a mortality of 41.8 per cent., no improvement at all. The great reduction in mortality after 1880 may be explained in part by improved surgical technic and better asepsis. but in part by earlier surgical interference. The conclusion reached by the leading authorities, at the time Fitz presented his paper on intestinal obstruction, was that medical treatment should be tried for at least two days before surgery was resorted to. Previously they had delayed even longer before submitting the patient to operation. It is well known that under such conditions the operative mortality will always be high. The immense amount of research work on intestinal obstruction since 1900 should have led to a still further reduction in the mortality rate.

The experience of Division B of the Surgical Service of the Hospital of the University of Pennsylvania comprises 124 cases operated on from September 30, 1922, to April 1, 1928. There were forty-five deaths, a mortality of 36.3 per cent. As a partial explanation for the high mortality we believe that a grouping of intestinal obstruction is desirable because of the different factors concerned in the etiology. the variations in surgical technics and the different grades of toxæmia encountered. By separating this series into groups we note the following:

TABLE I.

*Intestinal Obstruction.*

Division B—September 30, 1922, to April 1, 1928.

|  | Cases | Recovered | Died | Mortality Per Cent. |
|---|---|---|---|---|
| Total | 124 | 79 | 45 | 36.3 |
| Chronic types | 21 | 17 | 4 | 19.0 |
| Acute types | 83 | 58 | 25 | 30.1 |
| Acute post-operative ileus | 20 | 4 | 16 | 80.0 |
| Total without post-operative ileus | 104 | 75 | 29 | 27.8 |

* Read before the Philadelphia Academy of Surgery, January 8, 1929.

## CHRONIC TYPES

In this group are placed the cases in which long-standing subacute or chronic obstruction was evident, but toxæmia absent. There were twenty-one cases classed as chronic obstruction with four deaths. All the deaths were due to post-operative peritonitis. The series included eight cases of cancer of the colon, eight cases of adhesions following previous operations and five cases of miscellaneous lesions. As a whole these patients were advanced in years. The operations were frequently extensive. It seems fair to conclude that the obstruction played a minor part in the mortality of the group, post-operative infection being responsible for the deaths.

## ACUTE TYPES

There has been a great deal of experimental investigation directed at acute intestinal obstruction and many attempts to apply this work clinically. This will be discussed later. We were disappointed to find that we failed to lower appreciably the mortality figures from those published in past years. There were eighty-three cases in this group with twenty-five deaths, a mortality of 30.1 per cent. If it were not for the excellent results of the obstructed herniæ series, the mortality figure would be considerably higher.

TABLE II.

*Acute Intestinal Obstruction.*

Division B—September 30, 1922, to April 1, 1928.

| Etiology | Cases | Recovered | Died | Mortality Per Cent. |
|---|---|---|---|---|
| Obstructed herniæ ..................... | 44 | 39 | 5 | 11.2 |
| Old post-operative adhesions ........... | 14 | 8 | 6 | 42.9 |
| Carcinoma of bowel ................... | 13 | 8 | 5 | 38.5 |
| Congenital bands ..................... | 2 | 0 | 2 | 100.0 |
| Adhesions to mesenteric nodes ......... | 2 | 0 | 2 | 100.0 |
| Volvulus ............................ | 3 | 1 | 2 | 66.7 |
| Tuberculous peritonitis ............... | 1 | 1 | 0 | 00.0 |
| Impacted foreign bodies ............... | 2 | 1 | 1 | 50.0 |
| Carcinoma of jejunum ............... | 1 | 0 | 1 | 100.0 |
| Carcinomatosis .................. ... | 1 | 0 | 1 | 100.0 |
| Total ...................... | 83 | 58 | 25 | 30.1 |

From the above table it is evident that these cases fall into four general classes according to the etiology of the obstruction: those due to (1) obstructed herniæ, (2) bands and adhesions, (3) malignancies, and (4) miscellaneous conditions. The surgical problem in each class is quite different, as is also the ease of diagnosis.

*Obstructed Herniæ.*—From the standpoint of diagnosis and operative technic this group presents few difficulties. The mortality should be practically nil and yet in forty-four cases we had five deaths, a mortality of 11.3 per cent.

No attempt has been made by us to separate the so-called incarcerated from the strangulated group. Filing diagnosis of the inguinal group states that fourteen were incarcerated and six strangulated, and of the femoral

five were incarcerated and seven strangulated, but it seems to us that the border-line cases are judged by the surgeon one way or the other, largely dependent on the color of the bowel. Perhaps this is as perfect a method as is possible, but accurate deductions cannot be drawn. In this series the mortality of the "strangulated" group was 15.8 per cent. and in the "incarcerated" it was 8 per cent.

TABLE III.

*Intestinal Obstruction.*

Division B—September 30, 1922, to April 1, 1928.

*Obstructed Herniæ.*

|  | Cases | Died | Mortality Per Cent. |
|---|---|---|---|
| Inguinal ...................... | 20 | 4 | 20.0 |
| Femoral ...................... | 12 | 1 | 8.3 |
| Incisional ...................... | 7 | 0 | 0.0 |
| Umbilical ...................... | 4 | 0 | 0.0 |
| Internal ...................... | 1 | 0 | 0.0 |
| Total ...................... | 44 | 5 | 11.3 |

Apparently, the fate of the patient depends mostly on the speed with which he is operated on after obstruction (incarceration, etc.) is established. In thirty-nine cases in this group, where the elapsed time between beginning of symptoms to operation was given, it averaged 1.3 days. In twenty-nine cases the time was less than twenty-four hours and only one fatality (3.5 per cent.), in fifteen cases it was less than twelve hours, and in six less than six hours. Of fifteen cases obstructed over twenty-four hours four died (26.7 per cent.).

In 1913 Alexander [4] reported a series of 105 cases of strangulated hernia with thirty-two deaths (30.5 per cent.), ninety-nine were operated on with twenty-six deaths (25.2 per cent.). Thirty-four of these patients were operated on within twelve hours of onset with a mortality of 5 per cent. and twenty-nine were seen after twenty-four hours from onset with a mortality of 62 per cent.

*Post-operative Adhesions.*—In common with most observers, we found that appendicectomy with drainage and pelvic operations were the most common precursors of post-operative adhesions causing intestinal obstruction. The obstruction occurred from two weeks to twelve years after the original operation. This group carried a high mortality and yet we seem to be helpless in trying to prevent the complication, especially in the drained abdomen. Low-grade inflammation and raw peritoneal surfaces are probably the chief factors causing adhesions in the abdomen closed without drainage.

Diagnosis in this type of case is not always easy and the patient is apt to enter the hospital in a very toxic state. The surgical procedure to be followed requires experience and skill. In some cases the division of a band, thus freeing the obstructed bowel. is sufficient. In others, gangrene of the loop may indicate resection. or, as advised by some, the performance of a technic similar to the Mikulicz's operation. But, at times, in very toxic

patients, the question may arise as to whether it is not better simply to perform an enterostomy.

*Carcinoma of Colon.*—Unless the patient has been obstructed for a number of days the mortality from this type of obstruction should not be high. The low situation of the obstruction and the fact that dehydration is not a marked factor are important. The technical difficulty of performing colostomy in cases with great distention of the bowel, without soiling, is responsible for the deaths from peritonitis. It seems needless to remark that in the presence of acute obstruction no attempt at radical excision should be made, and, we believe, that in tight distention, without knowledge of the location of the lesion, a cecostomy without exploration should be the primary operation. All of our fatal cases except one died following simple colostomy or cecostomy. In only one case did we attempt a Mikulicz's procedure and this patient lived.

*Enterostomy.*—Enterostomy and jejunostomy are highly recommended in the literature [5] as life-saving procedures when indicated. Van Beuren and Smith have pointed out the high mortality in the cases of obstruction requiring enterostomy. This procedure is performed usually in the worst type of cases, in one that operation has been too long delayed, and is admittedly the last resort. Under such circumstances it has undoubtedly saved many lives. A patient with a high intestinal fistula, however, must be carefully watched since the fistula itself may be a factor in hastening death. Haden and Orr [6,7] have shown that, in dogs at least, a jejunostomy may be harmful and not beneficial. The mortality of the cases of acute obstruction in this series which we thought required enterostomy was 60 per cent. This figure agrees with the results of the survey reported by Van Beuren and Smith.[8] It is generally granted that the high mortality following enterostomy is due to late surgical interference, and experimental work has stressed the importance of delay as a factor in causing interference with vascular supply to the obstructed loop.

*Delayed Surgery.*—The rising mortality of delayed surgery in acute obstruction has been pointed out by most observers. In Finney's [9] series the mortality in the cases operated on in less than twelve hours was 5 per cent.; twelve to twenty-four hours, 11 per cent.; twenty-four to forty-eight hours, 31 per cent. Moore's [10] figures are as follows:

| Onset of Symptoms to Operation | Mortality |
|---|---|
| 0 to 24 hours | 0 |
| 24 to 48 hours | 25 per cent. |
| 48 to 72 hours | 33 per cent. |
| 72 to hours | 65 per cent. |

Tuttle [11] gives these results:

| Onset of Symptoms to Operation | Mortality |
|---|---|
| Under 6 hours | 0 |
| Under 12 hours | 4 per cent. |
| Under 24 hours | 15.4 per cent. |
| Under 48 hours | 18.0 per cent. |
| Under 3 days | 24.3 per cent. |

Our experience has been similar to those reported:

TABLE IV.

*Acute Intestinal Obstruction.*

Division B—September 30, 1922, to April 1, 1928.

| Onset of Symptoms to Operation | Cases | Died | Mortality |
|---|---|---|---|
| 0 to 12 hours | 17 | 0 | 0.0 |
| 12 to 24 hours | 16 | 2 | 12.5 |
| 24 to 48 hours | 18 | 11 | 61.1 |
| 48 or more hours | 24 | 12 | 50.0 |

### ACUTE POST-OPERATIVE OBSTRUCTION OR PARALYTIC ILEUS

Following operation for peritonitis, mostly caused by appendicitis, an obstruction may develop either from the paralyzing action of the suppuration itself or from angulation of the lower coils of ileum, adherent to the wall of an abscess or drainage area. Properly speaking, the latter is not true paralytic ileus, but a mechanical obstruction. The group is best termed acute post-operative obstruction. We have not been able to analyze our seven hundred cases of acute appendicitis operated on during these six years, but can recall many cases with obstructive phenomena which recovered without operation. Twenty were operated upon for post-operative ileus and there were sixteen deaths, a mortality of 80 per cent. The group presents many interesting features for discussion because, despite the complicating factor of the peritoneal absorption, it does seem that the mortality is unduly high.

When total obstruction occurs in these cases "it represents the end result of a progressive series of pathological changes dependent primarily upon the severity and extent of the intraperitoneal infection" (Wilensky[12]). In view of the fact that in such an obstruction there is no one occluding point, but rather a general matting together of adjacent adynamic loops, it seems as if the benefit of enterostomy may have been stressed unduly. It is proper to assume that in the cases of peritonitis with obstructive phenomena that recovered without operation, the peritoneal infection was mastered, the fibrinous exudate was absorbed, and the bowel resumed its normal activity. On the other hand, the patient succumbs when the natural resistance fails to control the peritonitis. It is difficult to ascertain in such cases whether the toxæmia of the peritonitis or that of obstruction is the greater factor in causing death. From experimental observation on animals it would seem that the toxins of obstruction are absorbed through damaged bowel mucosa only. Therefore, unless the obstructive phenomena are paramount, we do not believe that a great deal can be expected from enterostomy. At any rate our experience with this procedure in the acute post-operative group has been disappointing. Nineteen cases in this group had an enterostomy and fifteen succumbed, a mortality of 79 per cent. Of these nineteen enterostomies, at least five were jejunostomies with four deaths, and six were ileostomies with four deaths. Deaver[13] and Wilensky[14] do not consider jejunostomy in paralytic ileus satisfactory, and Wilensky states that in their clinic it is performed in but few cases of peritonitis.

Williams[15] suggests the use of *B. welchii* antitoxin in this type of case as well as in acute mechanical ileus. He believes that the toxæmia of intestinal obstruction is due largely to the absorption of *B. welchii* toxin. We have given the gas gangrene antitoxin to a few cases of acute post-operative obstruction, hoping that if we could neutralize the obstruction toxæmia the patient might better be able to overcome the peritonitis. We were able to observe little apparent benefit. However, we have not given it sufficient trial as yet.

### ACUTE MECHANICAL ILEUS

According to most observers, in acute mechanical ileus, death is due to the elaboration and absorption of a toxin in the gut. Certain investigators believe that this toxin is elaborated by the damaged mucosa of the obstructed loop and others believe it is due to the proliferation of certain bacterial flora. The most recent proponent of the latter hypothesis is Williams, whose theories have been referred to. Our experience with the use of *B. welchii* antitoxin has been limited and we are not in a position to discuss its efficacy.

The most interesting experimental observations in recent years have been the chemical changes found in the blood in experimental obstruction. It now seems probable that these changes are, to a large extent, due to the loss of sodium and chloride ions in the vomitus, obstructed loop fluid and urine. There has been some confusion in appreciating the significance of these observations due to the fact that the experimental obstruction has been usually of a different type than that commonly found clinically.

The experimental findings discussed may be summarized as follows:

(1) The higher in the intestinal tract the obstruction occurs the more rapidly fatal it is.

(2) Toxic substances apparently are formed in the proximal segment and are rapidly absorbed through a damaged mucosa, but not very readily through a normal mucosa.

(3) Acute intestinal obstruction should be divided into two classes: those without gangrene (simple), and those with gangrene (strangulated). The latter is much more serious due to toxic absorption through the mucosa.

(4) In *high (simple) obstruction* there is rapid fall in blood chlorides with a rise in carbon-dioxide combining power of the blood and a coincident rise in the non-protein nitrogen and urea.

These changes in the blood electrolytes have been most completely worked out by Haden and Orr. The demonstration by them, that the lives of the animals were greatly prolonged by the introduction of hypertonic saline under the skin and intravenously, led us and probably others to believe that we should be able to lower our mortality in acute intestinal obstruction.

Analysis of our figures by year failed to disclose any improvement. In contrast to this disappointing finding Coleman[16] reports two small series of cases, one in which he did not use hypertonic saline with a mortality of 50 per cent., and the other in which he used three-per cent. salt solution with a mortality of only 11.1 per cent. He credits the improvement wholly to the use of hypertonic saline. His two series of cases follow:

I.

Cases 20—Died 10—Mortality 50 Per Cent.

|  | Cases | Died |
|---|---|---|
| Paralytic ileus | 8 | 4 |
| Intussusception | 3 | 0 |
| Strangulated hernia | 4 | 2 |
| Carcinoma of colon | 3 | |
| cæcum | | 1 |
| sigmoid | | 1 |
| rectum | | 0 |
| Volvulus | 1 | 1 |
| Band | 1 | 1 |

II.

Cases 18—Died 2—Mortality 11.1 Per Cent.

|  | Cases | Died |
|---|---|---|
| Carcinoma of bowel | 6 | |
| rectum | 3 | 0 |
| colon | 2 | 0 |
| sigmoid | 1 | 1 |
| Strangulated hernia | 4 | 0 |
| Intussusception | 2 | 1 |
| Band | 4 | 0 |
| Paralytic ileus | 2 | 0 |

The changes in the blood chemistry described by Haden and Orr were in *high, simple obstruction*. Reviewing Coleman's cases and those in our series we find very few that we can class as such. These changes do not take place in *low, simple obstruction*. In an unfinished piece of investigation undertaken some time ago in the Department of Research Surgery we caused a low, complete obstruction in three dogs. This was done by bisecting the lower ileum and inverting the ends. The changes in the blood electrolytes were noted daily by Doctor Sunderman, of the Department of Research Medicine. There were no consistent marked changes in the non-protein nitrogen, chlorides, or carbon-dioxide combining power of the blood. The maximum non-protein nitrogen was 44, 36, and 28 milligrams per 100 cubic centimetres of blood, respectively. The carbon-dioxide combining power fell about the same as in control anæsthetization. The blood chlorides fell to 579, 567, and 556 milligrams per 100 cubic centimetres of blood, respectively.

Further, an animal with any form of *intestinal strangulation* is not saved by sodium chloride solution. The toxæmia is not relieved by such measures in contrast to the marked improvement seen in animals with *high, simple obstruction* (Gatch, *et al.*[17]).

In the light of the above facts, reëxamining the series of Coleman's cases as given, it seems doubtful whether the administration of hypertonic saline to restore the supposed deficient electrolytes of the blood was the prime factor in the improvement of his mortality rate.

In our series, complete blood studies were done in comparatively few cases. The disturbance of the serum electrolytes as described by Haden and Orr was found only once. In a few cases of duodenal and pyloric obstruction and "vicious circle" following gastro-enterostomy, not included in this

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series, the blood did show these changes. We were unable to demonstrate any marked advantage in the use of hypertonic saline over isotonic saline in our acute obstruction series, but we do believe that the parenteral administration of large quantities of isotonic saline is of great value both pre-operatively and post-operatively. This supplies both the electrolytes if needed and the fluid in its most available form to combat the dehydration which is always present.

## CONCLUSIONS

1. High, simple obstruction is not commonly encountered in the usual cases classed as acute intestinal obstruction. It is present in gastric, pyloric or duodenal obstruction due to tumor or ulcer and, occasionally, a band across the duodenum or high jejunum.

2. The marked improvement seen in animals with experimental high, simple obstruction, after the parenteral administration of hypertonic saline, cannot be expected in the ordinary case of acute intestinal obstruction.

3. One should not delay too long attacking the primary lesion in attempting to correct the disturbance of the blood electrolytes.

4. Isotonic saline may be preferable to hypertonic saline unless we know the blood chlorides are reduced, since dehydration is always present and we can administer a great quantity of fluid.

5. The most important factor in the high mortality of acute intestinal obstruction is still, what it always has been, delayed operation.

Dr. Selling Brill wishes to thank Dr. George P. Muller for his help and assistance.

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# BILATERAL ADENOCARCINOMA OF THE BREAST *

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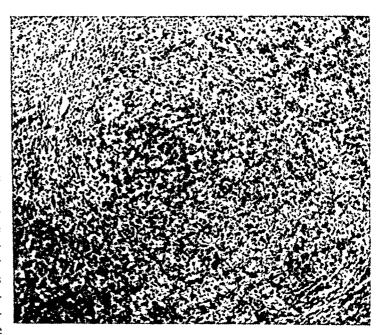
FROM THE MAYO CLINIC

CARCINOMA in both breasts is classified by Benassy in three groups: (1) Carcinoma of a second breast developing after amputation of the first, (2) carcinoma developing in a second breast from an original focus in the first, and (3) primary bilateral carcinoma. Cases in the first group are not uncommon; cases in the third group are rare. In the present case we are confronted also with the question whether the neoplastic disease arose from a single focus [3] in each breast or from multiple foci.

A woman, aged thirty-five years, mother of four living, breast-fed children, came to the clinic in January, 1927, with a diagnosis of adenocarcinoma of the left breast. One of her uncles had died of carcinoma, but her parents, four brothers, and three sisters were alive and well. One sister had died of intestinal obstruction. Four months before she came to the clinic the patient had severely bruised her



FIG. 1.—Adenocarcinoma of the left breast, graded 4, illustrating the histologic character of the malignant cells (x 100).

left breast and at that time a nodule, approximately 3 x 2 x 2 centimetres, had been observed. It persisted for three months, was painless, freely movable and did not increase in size. Three months after it first was noted, the nodule was excised by the patient's physician and a pathologist to whom it was sent diagnosed the lesion as adenocarcinoma.

At the time of the first examination at the clinic, the patient apparently was in excellent health. She had gained steadily in weight for several years. Laboratory tests of the urine and blood did not reveal evidence of disease. Röntgenograms of the chest did not give evidence of a pathologic condition. There was a scar on the left breast from a recent operation. Radical amputation of the left breast and axillary lymph nodes was performed. Scattered throughout this breast were eleven nodules of adenocarcinoma varying in size from three millimetres to one centimetre in their greatest dimensions. According to Broders's system, this was an adenocarcinoma, graded 4. (Figs. 1 and 2.) The carcinomatous nodules were distributed fairly regularly throughout the breast. Carcinomatous metastasis could not be found in the left axillary lymph nodes which were

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removed at operation. Histologically, the neoplasm was characterized by malignant, apparently rapidly growing, hyperchromatic cells, which were arranged in ill-defined acini and displayed very slight differentiation. In some areas the cells were closely packed together; in other areas their structure apparently was not so dense.

For ten months after the first operation the patient was in good health. Then she noticed a small "lump" in her right breast below the nipple. This nodule was freely movable, painless and was "watched" for a year by the patient's physician, without apparent change in size or consistence.

When the patient was examined at the clinic the second time she had lost ten pounds. Two freely movable nodules were present in the breast, one at about the five o'clock position and one at about the eleven o'clock position. The röntgenograms of the chest did not reveal any pathologic process of significance. Because of the previous history of carcinoma of the left breast, simple amputation of the right breast was advised and it was decided that this was to be followed immediately by radical amputation if the tumors were proved to be malignant by microscopic examination. After its removal the breast was found to contain thirty-three distinct, light brown to gray nodules; the largest of them was 3 x 2 x 1.5 centimetres in its greatest dimensions and the smallest, 8 x 3 x 3 millimetres. On microscopic examination, all nodules proved to be adenocarcinoma, graded 4. Radical amputation was completed at this time. All of the axillary lymph nodes that were removed were carefully examined grossly and microscopically and evidence of carcinoma was not found in them.



FIG. 2.—Higher magnification of the same area as that shown in Fig 1, showing more intimate details of the cancer cells (× 350).

Microscopic examination of all nodules in the breast revealed several features. These nodules all closely resembled the carcinoma found in the opposite breast. Generally, the malignant cells were closely packed together in ill defined acini. The nuclei were large and hyperchromatic and some of the cells were multinucleated. All of the nodules were so nearly alike that the sections might well have come from one nodule rather than from the thirty-three. Convalescence was uneventful.

## COMMENT

From the standpoint of surgical diagnosis these tumors of the breast are a marked exception to the general rule: although the nodules were carcinoma, graded 4, they were always freely movable, were not hard, and apparently did not increase in size, although observed over a period of several months.

It, furthermore, was unusual that although the tumors in each breast were highly malignant and although they apparently had been present for some time, axillary metastasis was not found. According to Harrington's recent study, the presence or absence of axillary metastasis is one of the most important factors influencing the prognosis in carcinoma of the breast.

From the data at hand it does not seem possible definitely to decide whether these carcinomatous nodules in each breast arose from a single focus in the left breast (the nodule first noted) or from multiple foci of carcinoma in each breast. In the light of Handley's centrifugal permeation studies it would seem that the small nodules of carcinoma in the breasts should have arranged themselves more or less centrifugally around the original focus of carcinoma in the breast, but they did not. The small areas of carcinoma were scattered promiscuously throughout the breasts. It is assumed that the largest nodule was the oldest one.

In favor of the origin of the carcinoma from a single area are: (1) The observation that the tumors apparently were counterparts of each other, and (2) the observation which has been made many times, that carcinoma of one breast is likely to metastasize to the other. In this case it seems that the carcinoma had a marked tendency either to originate in multiple foci or to spread widely in the tissue of the breast rather than to metastasize to adjacent lymph nodes.

Finally, this case illustrates again the fact that after all it is best to remove nodules of the breast and to examine them microscopically if there is any reasonable doubt as to the diagnosis. In this case, the nodules in the breast were multiple, freely movable and although observed for months did not change in consistence. All of these are fairly certain clinical signs of benign tumors of the breast, and still, this patient had multiple carcinomatous nodules in each breast.

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# BONE CHANGES IN GAUCHER'S SPLENOMEGALY*

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GAUCHER's disease has been defined as a constitutional disturbance of the albumin, fat and iron metabolism which expresses itself in specific changes in the reticulum cells of the lymphatic-hæmopoietic system. Since Gaucher described the disease in 1882, relatively few authentic instances (about fifty) of this unusual condition have been reported. Though the attention of the profession was called to the presence of bone marrow changes in this disease many years ago, the centre of attraction has very naturally been dominated by the striking metamorphosis which the liver and especially the spleen undergo. Relatively little mention has, however, been made of the presence of clinical and röntgenological evidence of the involvement of the osseous system. It is in the hope of focusing interest on this phase of the disease that the liberty is taken of reporting two cases, one of which has already been placed on record and the other of which is here reported for the first time.

The patient, whose history is here again presented. has been treated in several of the large institutions of this city and has been sporadically under the observation of one of us (M.) since 1924. It was only recently that we learned that in that same year, the study and positive diagnosis of this case by splenic puncture had been made the subject of a communication by Mark S. Reuben.[4] Since the clinical findings there noted correspond with those observed by us, the reader may more properly be referred to that excellent study for a statement of the details of the clinical picture. For the sake of completeness, we shall take the privilege of briefly recapitulating the positive findings and of calling attention to certain facts relating to the osseous system which in the press of consideration of the more prominent features of the disease missed the emphasis to which, we believe, they were entitled.

Sidney F., born in 1907, was the second of five children born of apparently normal parents. A younger brother was reported to have suffered from an enlargement of the spleen which, however, could not be demonstrated. The patient had the usual diseases of childhood. There was a history of frequent epistaxis. At the age of two he suffered from an attack of "acute articular rheumatism". At the age of fifteen, the patient again began to complain of pains in the shoulder and knee on movement, though there was no swelling or redness of the joints. At about this time, he suffered a fracture of the right tibia. In 1924, when seen in our office, he walked with a waddling gait and complained of pain in the right hip. No limitation of motion or bone tenderness could be elicited at this time. In 1925, he complained of pain in the right inguinal region which radiated to the right knee. For several years the patient disappeared from observation until he was again seen in 1927 in the out-patient department of the Hospital for Joint Diseases

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complaining of "rheumatism". This time, however, there were definite clinical signs of bone and joint involvement, as the patient walked with a marked waddle and had to be lifted upon the table for examination.

The patient was definitely under-developed both mentally and physically for his age, though appearance suggested that of a wizened, little, old man. The skin was dry and wrinkled and of a *café-au-lait* color. There was a well-developed bilateral pinguecula formation. The abdomen was immense and was seen to be distended by a huge spleen reaching to the crest of the ilium and by the liver which could be easily palpated several fingers' breadth below the umbilicus. No ascites was present. The genitalia were under-developed and the pubic hair showed an infantile growth. Over the tibiæ, however, there was an unusually profuse growth of coarse hair. There was a moderate increase in the size of the submaxillary, axillary, and inguinal lymph-nodes. There was no limitation in the motions of the spine or upper extremities and no bone tenderness could be demonstrated. The knees and ankles were found to be normal and the pain in the knee was presumed to be due to involvement of the hip-joints. The right hip was found completely immobile, probably due to muscle contraction and fibrous ankylosis. The left hip was found in adduction contracture with only slight movement possible. There was no relative shortening. An X-ray of both hips and subsequently of the entire skeletal framework was ordered and was reported in the following sense:

"The bones of the skull show definite alterations. The frontal regions show diploëtic absorption with cortical thinning.



Fig. 1.—Shows irregular absorption of capital epiphysis with mottling of the shaft of the humerus below the epiphyseal line.

The bones of the parietal region appear to be normal. The occiput shows definite diploëtic absorption or rarefaction with marked thinning of the cortex. No periosteal proliferation noted. The vascular grooves appear to be slightly accentuated, but there is no definite indication of increased intracranial pressure. The clinoid processes appear atrophic, although the sella turcica is of normal size, shape and appearance. There is no erosion of the floor of the middle cranial fossa.

"The ribs proper show no specific alteration aside from an apparent cortical thinning. The spine shows no changes. Examination of the pelvis shows bone absorption which is more pronounced in the right ilium, particularly about the margins of the acetabulum. Here also there are patchy islands of bone sclerosis. The epiphysis of the right ilium appears to be under-developed, whereas its counterpart of the opposite side appears to be normally formed. The sacrum is negative. Both pubic bones show medullary absorption more marked, however, on the left side, where a small area in the upper anterior angle of this bone appears to have been completely absorbed. The right acetabulum proper

shows slight marginal sclerosis. The left, however, shows an absence of a normal acetabular roof.

"Both shoulder-joints are narrowed and the capital epiphyses show irregular cystic absorption. (Fig. 1.) This change appears to be more marked on the left side. No actual joint destruction is present. The upper ends of the humeri show a mixed process; irregular areas of central medullary rarefaction alternating with medullary sclerosis. The cortex about the areas of rarefaction appears to be thinned out but is not perforated, whereas the cortex in the reactive areas shows definite and fairly pronounced thickening.



The middle thirds of the humeri show this medullary rarefaction most characteristically. Examination of the bones of the wrist-joints and hands shows slight atrophy of the epiphysis of the radii with no other demonstrable change The remaining bones of the hands show medullary expansion without any cortical change aside from slight thinning. The terminal tufts of the phalanges are intact.

"The right hip-joint shows a patchy sclerosis involving the head and neck as well as the intratrochanteric region. The epiphysis proper is slightly compressed. The neck is foreshortened and there is an early coxa valga deformity present. (Fig. 2.) The left hip shows compression atrophy of the capital epiphysis, the edges of which appear to have undergone moderate proliferation. The femur on this side shows a pronounced medullary absorption throughout. The neck is foreshortened with a tendency toward a coxa vara deformity. The femori show central medullary absorption throughout the upper halves. The middle one-thirds of both femori show medullary and cortical sclerosis. The lower one-thirds, particularly the inner aspects, show irregular bone atrophy or absorption. Some expansion appears to be present in the lower one-thirds of these bones. The left femur shows a slight reactive periostitis along its outer margin, lower one-third. (Fig. 3.) The knee-joints appear to be normal. Examination of both lower extremities shows central medullary rarefaction in the upper one-thirds of the tibiæ with slight thinning of the cortex of these bones. The lower ends, immediately above the ankle-joints, show transverse calcific striations characteristic of an old rachitic process. No evidence of former fracture. Examination of the bones of the feet shows an increase in the width of the medullary cavities, with thinning of the cortices of all the bones of these parts. The tips of the terminal phalanges lack the normal and usual tufted appearance; the terminal phalanges proper being rounded off."

Fig 2—Shows deformity of the femoral head probably due to replacement of normal bone structure by ingrowth of reticulum cells.

For the details of the second case we are indebted to the courtesy of our colleagues, Dr. Martin Vorhaus, who first saw the case, and Dr. Philip Grausman, who subsequently performed a splenectomy. As in the preceding instance, this patient had been seen in a number of the large institutions of New York City and in one had been subjected to operation for what was believed to be an acute osteomyelitis of the tibia. In this case as in the other the first symptoms were those referable to the osseous system. Though the röntgenographic evidences are by no means as definite as in the first case, there is no doubt in our minds but that this case too must be grouped with those other instances of Gaucher's disease in which the bones have shown involvement.

Rebecca F., a clerk, aged twenty-one, was the eldest of five children born of apparently normal parents. The four younger brothers showed no symptoms suggesting splenic enlargement. The patient had always been considered "weak". The mother had noticed a marked enlargement of the abdomen since infancy. During childhood, the patient suffered from measles, mumps, diphtheria and pertussis. At the age of one and one-half an abscess on the right side of the neck developed. When five years old, the child fell and thereafter complained of a pain in the right knee and



FIG. 3.—Shows expansion of the lower third of the femur associated with medullary absorption and cortical thinning.

tibia which she attributed to the fall. She was seen at one of the large city hospitals and was referred thence to another institution for the application of a plaster cast. The pain disappeared and the cast was discarded. At the age of nine, she again complained of pain in the right leg and X-ray plates taken at this time demonstrated "something wrong in the right tibia". Again a plaster cast was applied and again after the lapse of several months the pain was relieved. At the age of eleven, because of the presence of a hæmaturia and pains in the right knee, a diagnosis of "rheumatism" was made and tonsillectomy was performed. At this time also the splenomegaly was first noted. For two years following tonsillectomy she was free of symptoms and then as a result of the recurrence of pain, she went to one of the large orthopedic hospitals of this city where a diagnosis of "tuberculosis of the hip" was made and a plaster spica was applied. She was sent to a country convalescent home where she first noticed her "attacks" of headache, nausea and dizziness. The spica remained on for about eight months, when she was examined in another orthopedic institution and absolutely no evidence of hip involvement found.

In 1920, the patient complained of intense pain in the right tibia which rapidly increased in severity so that she was unable to walk. There was no history of chills, no loss of appetite, no malaise except for the pain in the leg. The leg, however, was dusky-hued, swollen and exquisitely tender to touch. A diagnosis of acute osteomyelitis was made and the patient referred to the hospital for immediate operation. The operation was performed by the late Doctor Barrie. "A linear incision was made along the inner anterior aspect of the middle third of the right tibia. An opening through the fat and fascia disclosed a bluish-gray periosteum bulging in all directions. Incision over the periosteum caused spurting of the dark bloody fluid. In all directions, periosteum was stripped from the bone. A wedge one-half inch by one and one-half inches was removed and two small sequestra surrounded by granulations were removed. Visible pus was also present." Immediately following osteotomy, the temperature dropped to normal and remained normal without a single elevation until her discharge to a convalescent home seven weeks after operation. For a period of about two years the bone sinus remained open, occasionally discharging small sequestra, but the pain has been eliminated up to the present time.

During the year or two preceding her admission to the Hospital for Joint Diseases the patient complained of repeated recurrences of her "attacks" of nausea and dizziness. When seen at our hospital the patient presented the characteristic clinical appearance of one afflicted with Gaucher's disease; bilateral pinguecula formation, *café-au-lait* color, small petechial hæmorrhages into the skin of the face and forearms, a liver enlarged to two fingers' breadth below the umbilicus and a spleen reaching to the crest of the ilium, no ascites. The urine and Wassermann tests were normal. The blood picture showed hæmoglobin 60 per cent., red blood cells 3,004,000, white blood cells 4,000, polymorpho-nuclears 46 per cent., small lymphocytes 40 per cent., large lymphocytes 13 per cent., basophiles 1 per cent., blood platelets 288,000, coagulation time three and one-half minutes, bleeding time one and one-half minutes. Over the inner surface of the right tibia there was an adherent scar about three inches long. At this level the right tibia measured thirteen and one-half inches in circumference as compared with the left, which at the same level measured only twelve and one-eighth inches. There was no pain or bone tenderness either in this region or over any of the other bones. There was no limitation in any of the joints of the body. On March 22, 1927, operation was performed and a spleen weighing 1,332 grams, measuring about twenty-seven centimetres in its greatest diameter and presenting all the gross and microscopic appearances of the typical Gaucher splenomegaly was removed. The patient made an unusually uneventful recovery and since her operation (fifteen months ago) has gained five pounds in weight. Though she still tires easily after exertion she feels a marked increase in her strength. The liver is slightly smaller than before operation and the yellowish color previously present has disappeared. The "attacks" of nausea and vomiting as well as the tendency to hæmorrhage appear to have been completely controlled. The pinguecula are still present.

X-ray plates taken recently showed a small and rudimentary type of sella turcica. The rest of the bones except the tibia showed no changes. "Examination of the right tibia shows a definite process involving the upper two-thirds of this bone. There is a dense endosteal and periosteal sclerosis with an actual increase in the diameter of the shaft proper. An area of central medullary rarefaction is seen immediately beneath the condyles and may represent active destruction at this point. The lower one-third of this bone shows definite medullary absorption. No periosteal changes are demonstrated over this site. There is a periostitis of the shaft of the fibula at the junction of the middle and upper thirds. The original changes in the upper two-thirds of the tibia cannot, of course, be determined at this time in view of the reactive changes following earlier operative intervention. The process in the lower third of this bone may well simulate the appearance noted in other cases of Gaucher's disease."

Unfortunately, we have been unable to get any of the X-ray plates taken prior to operation by Doctor Barrie. Out of respect for his admittedly great knowledge of the pathological conditions of bone, the possibility of an acute osteomyelitis must be admitted in this case. However, in view of the clinical history of this patient, we feel that this designation may erroneously have been applied to what was in reality a case of Gaucher's disease with bone symptoms. The long history of recurrent, afebrile attacks of bone pain, the sudden onset of the last attack without clinical evidence of a septicemia or even a severe toxemia, the relatively low-grade fever and the abrupt fall to normal temperature following operation, all seem to lend credence to this belief. The "visible pus" seen at operation may well have represented the bone necrosis which Pick has shown is the consequence of the ingrowth of the Gaucher cells. On the other hand, the sudden swelling of the leg, the development of a dusky color to the skin, the exquisite tenderness, the spurting out of "a dark bloody fluid" after incision of the tense, bulging periosteum stripped away from the underlying bone seem to point not to an acute infectious process but rather to a vascular accident, a subperiosteal hæmorrhage, the counterpart of the hæmaturia noted in childhood and the petechial hæmorrhages seen upon admission to our hospital.

It is interesting to call attention to the fact that in these two cases as in two others to be mentioned later, the diagnoses of rheumatism and bone tuberculosis were first made before pathological examination elucidated the true underlying cause. It is further interesting to observe that, though the bone marrow changes were undoubtedly antedated by unnoted enlargement of the liver and spleen, the first symptoms for the treatment of which these patients presented themselves were referable to involvement of the long bones.

The bone changes characteristically seen in this disease appear to have been first noted in 1904 as a result of the clinical acumen of Dr. Emanuel Libman. Nevertheless, in spite of our present knowledge of the bone marrow involvement, the cases in which symptoms indicating such lesions have been recorded appear to be relatively few. Out of a series of nineteen cases which he reviewed, Reuben noted the presence of bone tenderness in only three. Brill, Mandlebaum, and several other authors have recorded bone tenderness en passant in their case histories, but none of these have apparently observed actual bone destruction or change demonstrable either clinically or by röntgenographic examination.

In 1922, Pick[3] called attention to the fact that Gaucher's disease may show marked variations in the extent of involvement of the different parts of the lymphatic hæmopoietic system. In the case he reported the "changes in the spleen and liver were relatively in the background of the clinical-anatomical picture, so that Gaucher's disease, as such unrecognized, gave the impression and received treatment as a bone disease". This patient, a man of forty years, presented no symptoms until the age of twenty, when recurrent pains in the left femur were noticed. Gradually, a swelling of the lower end of the femur and a gibbus in the dorsal spinal region developed. The patient

was treated by traction in recumbency without any relief. Subsequently, he was operated upon for what proved to be a fatal carcinoma at the liver portal, and the autopsy disclosed facts of interest in the present consideration. Apart from the more usual morphological changes in the liver and spleen, which absolutely established the diagnosis, there was extensive involvement of all the bones examined. The pelvic and long bones, especially the femur, showed the presence of huge soft grayish and reddish tumor masses of typical Gaucher's cells in the marrow spaces. The fifth lumbar vertebræ was compressed and wedge shaped. The gibbus, clinically noted, was found to be due to a breaking down and compression of the eleventh and twelfth dorsal vertebræ. In contrast to the findings in tuberculous compression, however, the ligamenta intervertebralia were here found intact, as might probably have been expected in a case of non-infectious origin.

In 1927, Santee,[5] too, reported a case in which the diagnosis was established by splenectomy and in which, as in Pick's case, the first symptoms were referable to the osseous system. The patient, a man of twenty-nine years, was first seen complaining of "a sprain of the left hip, following a jump on a roof, eighteen months beforehand. This was followed gradually by increasing disability in the left hip, particularly on active use". He was treated in a Brooklyn hospital by rest in bed, traction, suspension, walking Thomas calipers, etc., without relief. When seen by Santee, radiograph showed "a slight irregularity and loss of detail lower half margin head of left femur, which is tuberculous in appearance without extensive bone destruction. Head of femur faintly mottled which may be due to slight rarefaction. The presence of a Gaucher's type of splenohepatomegaly was recognized and splenectomy performed. Following operation, the patient's general condition was apparently definitely improved, but six months later, "his hip shows no apparent change".

From the study of the cases which have been noted above, the panorama of practically all of the bone manifestations in Gaucher's disease may be reconstructed. The pathological changes seen in the stage of early bone involvement perhaps have been best described by Brill, Mandlebaum and Libman.[1] "Cells identical with those found in the above organs (liver, spleen, etc.) are found in abundance in the bone marrow. . . . Occasionally a large mass of cells is noted, but for the greater part they are found either singly or in groups of from four to ten cells. In the latter instance the cells are always found in intimate relationship with the walls of the capillaries or attached to the connective tissue reticulum. The larger masses cannot always be seen to have such a relationship, and occasionally they are found surrounded by a considerable number of red blood cells. In a few places the cells are distinctly seen within the lumen of the dilated capillaries."

Unfortunately, the specimen from which this report was written appears to have been taken from the femur of the patient, while the site of the greatest pain and presumably also of the greatest pathological changes was in the tibia. The subsequent opinion of Brill and Mandlebaum[2] that "no charac-

teristic variation in the degree of involvement between the early and advanced cases is apparent" must therefore be taken with a great deal of reserve. In the advanced case referred to before, Pick found extensive disease of the bones with nodular tumor formations as well as diffuse infiltration in the bone marrow. Microscopically all stages of development of the Gaucher's cells were demonstrable in the bone marrow. There was a peculiarly characteristic tendency of these cells to take on long spindle-shaped and fascicular forms. As a consequence of their massive growth in the marrow spaces, the bone trabeculæ gradually underwent atrophy and subsequent disintegration. The end result consisted of a mass of necrotic bone trabeculæ held together by a relatively anuclear fibrous tissue, which developed *pari passu* with the intense proliferation of the reticulum cells.

The clinical correlative of the early pathological change is doubtless envisaged in the vague pains, the "rheumatism" and the bone tenderness already mentioned. As the disease progresses, and as the bone changes become more pronounced, the patient begins to note greater and greater pain and disability in the bones or joints, and the attention of the physician becomes focused more upon the local condition than upon the systemic disease at the basis of the patient's complaints. In the advanced stage, where destruction of the bone has already taken place and deformity has developed, the patient necessarily becomes the object of the orthopedist's solicitude whether the diagnosis has been made or not. Usually, of course, the diagnosis of Gaucher's disease is made by the clinician. Occasionally, as in those cases where symptoms referable to the osseous system appear before the development of the pathognomonic splenohepatomegaly has attracted attention, it may be of value to bear in mind the value of radiologic examination of the affected bones.

Röntgenologically, the changes in the bones in Gaucher's disease are characterized by medullary absorption, cortical thinning and expansion of the bone. The medullary destruction which takes place not as a diffuse process but in the form of scattered islands doubtless represents the sites of proliferation of the Gaucher cells. This alternation of areas of absorption with areas of denser bone formation gives the plate a characteristic mottled appearance. Whether the surrounding areas of relative osteosclerosis represent nature's efforts in reparation or the unaffected internodular spaces, it is impossible for us to say. However, in view of the röntgenologic evidence of bone repair presented by the two cases above reported, it may be presumed that the mottling is due, in part at least, to a stimulation of osteogenic forces. The cortical thinning and the bone expansion are doubtless the result of the increased subcortical pressure exerted by growing cell masses, and are in all likelihood the explanation of the bone tenderness and pains described by the patients. Similarly, the cystic areas of absorption noted in the joint surfaces probably bear witness either to invasion of the cartilage by the cells or to the necrotising effects of pressure of the subjacent cells upon the cartilage. Periosteal changes are usually slight.

Especially in its later stages, Gaucher's disease is usually fairly easily

diagnosed. However, in the type in which symptoms referable to the osseous system predominate, it may occasionally be necessary to exclude the presence of tuberculosis, lues, leukemia or so-called "rheumatism". Clinically, the differential diagnosis may be established by the absence of a leukemia, or a polycythemia, the negative Wassermann, the presence of pingueculæ and the enlargement of the liver and the spleen. Röntgenologically, too, the diagnostic criteria are fairly definite and the differentiation offers no difficulty. Tuberculosis is characterized by the presence of extensive articular destruction and an associated dense synovitis. There is marked atrophy of the bone, but no areas of cystic degeneration in the juxta-articular region as in Gaucher's disease. In this latter disease, the lesions are generalized, while in tuberculosis they are usually localized to one joint. In tuberculosis, in the absence of a mixed infection, there are no periosteal or endosteal sclerotic changes and the mottling described as occurring in Gaucher's disease is not seen. In lues, on the other hand, the marked periosteal and endosteal changes may resemble very closely those seen in Gaucher's disease. However, here there is more evidence of a generalized periosteal reaction with a pronounced tendency to osteosclerosis. Except in cases of superimposed pyogenic infection, lues does not lead to bone atrophy and the characteristic alternation of sclerosis with areas of medullary absorption does not occur. Joint syphilis is usually of a destructive nature as in Charcot's disease, while in Gaucher's disease the articular lesions are more defined by atrophy than by destruction. Recent descriptions of the röntgenographic evidence of bone changes in lymphatic leukemia have stressed the appearance of periosteal reactions. However, these cases do not show the endosteal sclerosis, the atrophy, the joint changes or the medullary absorption which have been noted in Gaucher's splenomegaly.

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# OSTEOMYELITIS OF THE VERTEBRÆ

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In previous communications the mechanism and pathogenesis of acute osteomyelitis in general was extensively discussed. The present paper concerns itself with osteomyelitis of the vertebræ of the spinal column. The principles of the pathogenesis of acute osteomyelitis in general will be incorporated in this paper as they apply to osteomyelitis of the vertebræ; and the phenomena and extraordinary features of infection of the latter bones will be found to be caused in the ordinary way and to be explainable by the situation of the lesion and by its relation to neighboring cavities, viscera, or other important structures.

This communication will consider only those cases of acute osteomyelitis of the vertebræ which are caused by the common pyogenic organisms— staphylococci, streptococci, etc. It will not include any cases due to such extraordinary infecting agents as tubercle bacilli, actinomyces, etc.; nor those cases of chronic spondylitis due to typhoid bacilli; nor cases of ·chronic spondylitis due to other obscure etiology and usually known by such terms as spondylitis, chronic hypertrophic arthritis, etc.; and finally no case of luetic infection.

Such cases of acute osteomyelitis of the spinal vertebræ are comparatively small in number. The paucity of numbers is due in largest measure to the lack of complete knowledge of the manifestations of acute osteomyelitis of the spine among the profession, because of which the diagnosis is not made in many cases. A wider diffusion of knowledge concerning the pathological facts and the clinical possibilities seems necessary; and, undoubtedly, as a consequence of this, correct diagnoses will be made of this condition in those hitherto obscure cases, and reports of cases of this type will increase in number.

There is very little American literature upon the subject. The European literature is considerably more extensive and contains a number of communications published at intervals, in which studies were made of comparatively large series of cases at the larger continental clinics. The remaining papers consist mostly of case reports.

The first case of osteomyelitis of the spine was reported by Lannelogue in 1879. The first important communications were made by O. Hahn in 1895 and in 1899. He combined the cases compiled by Frohner with those from the Bruns clinic. In the 661 cases of osteomyelitis of all the bones of the body thus obtained, fifty-one cases of acute osteomyelitis involved the small and irregular bones and, of these, only one case was found to affect the vertebræ. This gives a proportional figure for Hahn's cases of 1 :661 as the relative frequency of acute osteomyelitis of the vertebræ at that time—a truly small

and insignificant proportion. Hahn, however, calls attention to the great probability of many of the cases not having been diagnosed.

Hahn summarizes the result of his investigations as follows:

(1) Acute osteomyelitis of the vertebræ does not form any exception when compared to the other bones, as far as occurrence, etiology and progress of the disease are concerned; however, in many cases it results in severe complications, which are brought about by the extension of the suppuration to neighboring cavities of the body and to the central nervous organs.

(2) It is possible to make a diagnosis in most of the cases if the characteristic symptoms are taken into consideration. The establishment of a diagnosis may be made very difficult if there is an early extension upon the spinal cord and brain, or if there are other complications, or a pyemia, which sets in early.

(3) The prognosis is serious, dependent upon the character of the infection and upon the general condition of the patient, the seat of the disease on the different portions of the spinal column and on the different parts of the vertebræ, and on an early recognition and interference.

(4) The therapy should be as early an interference as the difficulty in establishing a diagnosis in the individual case will permit. It should be active as far as possible. It is limited, however, in those cases in which the process has extended already as far as the central organs, or in which other severe complications exist, especially when pyemia has already set in.

Makins and Abbott's paper in 1896 is a very extensive and excellent review of the subject up to that time and includes all of its phases.

Daverne's thesis, published in 1903, is a very complete review taking in Hahn's work also. He refers to and quotes extensively from the observations of Chipault and of Bergmann and Mickulicz.

Donati's paper in 1906 summarized the experience of the European clinics up to that time. Donati collected fifty-five cases from the literature and added one personal case.

Goebell's paper in 1910–11 paid special attention to the spinal meningeal complications of this disease.

Volkmann's communication in 1915 came next. On the basis of eighty-seven cases from the literature and four personal cases he made an exhaustive study of the disease.

Schwartz's paper in 1920 paid special attention to the spinal cord complications of osteomyelitis of the spine.

All of these men recognized two important factors: (1) the difficulties in making diagnosis in all obscure cases; and (2) the danger of the disease because of its potential complications within the spinal canal. All of the writers recognized the fact that osteomyelitis was part of a general infection (pyemia).

*Frequency.*—The relative frequency of vertebral osteomyelitis among all forms of acute osteomyelitis in general is rather difficult to determine from the reports in the literature owing to the fact that the cases reported are gathered from a great number of sources, and in none of the reports is there given any basic figures from which the proportion could be calculated. In the last ten years there have been treated at the Mount Sinai Hospital 578 cases of osteomyelitis of all kinds and varieties. Among these there were nine cases of osteomyelitis of the spine—a proportion of 1.5 per cent. The difficulty with these figures, as was pointed out repeatedly by the other men, is that undoubtedly some cases are not diagnosed as osteomyelitis of the

spine, but are classified in the records as cases of general infection (pyæmia, bacteriæmia, etc.). At any rate, an important fact to remember is that acute osteomyelitis, while an unusual lesion in the bones of the spine, nevertheless exists and one should be on one's guard for its discovery.

*Sex.*—In Volkmann's series 72 per cent. of the cases were in men. According to Donati's figures 68 per cent. occurred in men. In our series 55 per cent. of the cases were in men.

*Age.*—The spread of the disease among the various decades of life is shown in the following table:

| Age | Donati Cases | Daverne Cases | Makins and Abbott Cases | Mt. Sinai Cases |
|---|---|---|---|---|
| Up to 10 years............. | 15 | 12 | 5 | 2 |
| 10 to 20 years............ | 24 | 6 | 11 | |
| 20 to 30 years............ | 11 | 9 | 3 | 3 |
| Over 30 years............ | | | | 4 |

Fifty per cent. of Volkmann's cases were between eight and seventeen years of age. Hence, in common with all cases of acute osteomyelitis, most cases of osteomyelitis of the spinal vertebræ occurred during the period of adolescence.

*Distribution.*—The distribution of osteomyelitis of the spine among its various segments is shown in the following table:

| Region | Daverne Cases | Makins and Abbott Cases | Mt. Sinai Cases |
|---|---|---|---|
| Cervical ............... | 7 | 3 | 2 |
| Dorsal ............... | 12 | 5 | 2 |
| Lumbar ............... | 17 | 10 | 4 |
| Sacral ............... | 5 | 3 | 1 |

*Pathogenesis.*—Acute hematogenous osteomyelitis is a metastatic lesion during the course of a bacteriæmia, the latter resulting from an acute bacterial lesion on a surface of the body which forms the portal of entry for the infection. In this conception a surface of the body includes not only the skin, but also the entire mucous membrane of the alimentary tract, the genito-urinary tract, etc. The common surface lesions include not only furuncles, carbuncles, etc., on the skin, but also easily demonstrable lesions in the tonsils, and in other lymphadenoid collections lying in the mucous membrane of the pharynx, as well as less demonstrable lesions, such as those in the Peyer's patches.

The fundamental cause of the spreading of the original lesion in the form of metastatic or subsidiary lesions is an infected thrombus lying in the original area of infection, and communicating at some point with the freely circulating blood. Organisms, growing on the surfaces of the thrombus, are discharged,

or pieces of the thrombus itself break off and are discharged into the circulation and, becoming lodged for various reasons in the vascular network of various parts of the body, give rise to secondary lesions. Bone tissue, because of its peculiarities in vascular structure, seems particularly prone to the blocking of these thrombo-emboli and the susceptibility to this is particularly increased during the period of growth when the individual bones contain well-marked divisions into diaphysis and epiphysis.

The various accessory causes, such as trauma, that determine the localization of a secondary focus of infection—fixation point—in a given bone, are associated with accidents in the local circulation which facilitate blocking of any bacterial thrombus-embolus. The essential nature of the pathologic process that develops at the fixation point is a thrombo-arteritis or thrombophlebitis, and the process in the vertebræ is exactly similar to that in other bones in which a dominating position is assumed by the secondary vascular thromboses which must necessarily occur in such a pathological lesion. The all-important secondary effect which these thromboses produce are disturbances of essential nutrition which lead to the death of certain bone cells and the consequent necrosis of certain areas of bone tissue. In the vertebræ these secondary effects occur in the minimum degree because of the characteristics of the local circulation, as will be pointed out subsequently.

The lesions of acute osteomyelitis in the spinal vertebræ are understood only in the light of complete knowledge of the anatomical structure of the bones and of the arrangements of the vascular supply of the individual bones.

The anatomy of the spinal vertebræ is well understood. The heaviest part of the bone is formed by the body which forms the anterior and major portion of the structure. The posterior part is formed by the pedicles on either side which, proceeding backward and toward the median line as the laminæ, serve to form enclosure in which the spinal cord is lodged. The transverse processes and the spinous processes are developmental or rudimentary structures which serve for the most part for the attachment of the various muscles. The heaviest vertebræ are in the lumbar region. That part of the completed spinal column which is most mobile is the cervical portion; next in order come the lumbar vertebræ; in the sacrum the vertebræ have become fused together to form single structure.

Anatomically the vertebræ are formed chiefly of cancellous bone. The body is composed of exceedingly light spongy tissue having a thin coating of compact tissue on its exterior perforated by numerous openings for the ingress and egress of its numerous nutrient vessels. The arch—the pedicles and laminæ—have an exceedingly thick covering of compact tissue and the amount of cancellous bone in the interior is negligible or, in some, entirely absent.

An important item in which the vertebræ differ from most other bones is found in the structure of its periosteum. A true membrane resembling those which are typically found in other bones is wanting. This seems to be necessary because of the mechanical principles upon which the spine, as a whole, and its muscular attachments are built. The superposition of individual bones of comparatively small size to form a rigid and at the same time flexible stem, upon which the rest of the body is hung and supported, makes necessary the complicated joint interlockings which are so typical of the individual vertebræ and of the spine as a whole. Rigidity is obtained by heavy ligamentous structures which hold the bones together and which find and make for the security of the spine as a whole by making deep anchorages in the bone tissue. These ligamentous insertions cover the major part of the entire vertebral surface on the outer and inner side, and the inter-

vening portions are occupied by the tendinous attachments of the spinal muscles which likewise are deeply inserted into the osseous tissue. These tendinous, fibrous and ligamentous structures take on the functions of the periosteum. Their anatomical arrangements

are of maximum importance in determining the paths along which suppuration will spread. This will be discussed subsequently.

The blood supply of the bodies of the vertebræ is larger than that for the pedicles and the laminæ. There is a very abundant v a s c u l a r arrangement for the vertebral bodies arising by a large number of vessels corresponding roughly in number with the number of spinal segments. These are derived from n e i g h b o r i n g large main trunks—the basilar in the neck, the intercostal and other branches in the thorax, and the lumbar vessels in the loin. There is a double arrangement — corresponding to the external aspect of the vertebræ and to the interior of the spinal canal. One group of vessels perforate the bodies of the vertebræ from the outer side and break up into a network which supplies the appropriate p a r t s of the bone with blood. These finally anastomose with the n e t w o r k derived from those branches which, having entered the spinal canal, ramify in its interior. Those on the exterior of the bone follow no readily classifiable scheme. The arrangement in the interior of the spinal canal follows the following plan.

The lateral spinal branches enter the spinal canal through the intervertebral f o r a m i n a and divide into two branches. Of these, one passes along the roots of the nerves to supply
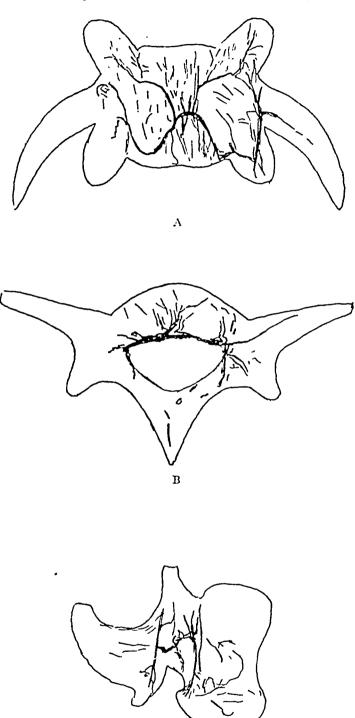


Fig. 1.—Injection specimens showing blood supply of a typical vertebra. A shows the blood supply when viewed anteriorly. B shows the blood supply when viewed superiorly. C shows the blood supply of the anterior of the spinal canal when viewed from the side. Taken from Kuliga and Turck.

the spinal cord and its membranes, anastomosing with the other arteries of the spinal cord; the other divides into an ascending and a descending branch, which unite with similar branches from the artery above and below, so that two lateral anastomotic chains

are formed on the posterior surface of the bodies of the vertebræ near the attachment of the pedicles. From these anastomotic chains branches are given off to supply the "periosteum" and the bodies of the vertebræ, and to communicate with similar branches from the opposite side; from these latter small branches are given off which join similar branches above and below, so that a central anastomotic chain is formed on the posterior surface of the bodies of the vertebræ.

The blood supply of the arches—the pedicles, laminæ and processes—is very much less abundant than that of the bodies and, except for some small perforating branches which are derived from various muscular arterial branches in their immediate neighborhood, the greater part of the blood supply proceeds from the terminal anastomosing ramifications of the network formed from the spinal arteries in the interior of the spinal canal.

Because of these essential anatomical and vascular conditions, thromboembolic lesions in the vertebræ do not follow any particular plan. Lesions are produced which are of irregular size and shape and the size and extent of the latter are determined by the vascular collateral circulation. The involvement is generally of comparatively small size, and more frequently affects the arches and processes of the bones in the lumbo-dorsal region and the bodies of the vertebræ in the cervical region. According to Donati the spinous processes are affected most commonly, the articulating processes next, and the transverse processes least frequently. In three-quarters of the cases in our experience only one vertebræ is affected. According to Bergmann and Mikulicz the disease is not often limited to a single vertebræ; Chipault believes that this occurs only in the sacrum.

The actual involvement is generally of small size. Generally only the "periosteal" layers or the superficial lamellæ of the bone are involved; less commonly the focus extends more deeply into the bone. Owing to the free vascular anastomosis, the formation of sequestra is not constant; and the latter are commonly of inconsequential size. The formation of abscesses is much more common; the mechanism of their formation is that of subperiosteal abscesses in general, as described previously. Depending upon the directional tendency of the infection in the various divisions of the vertebræ, the abscesses have the tendency to extend backward or forward. The paths along which suppuration spreads are well defined because of anatomical conditions and can be classified along the following lines:

*A*. Suppuration on the exterior surface of the vertebræ.

*B*. Suppuration in the interior of the spinal canal.

A. In the various segmental regions of the spine, the following pathological-anatomical details can be distinguished:

*AA. The Cervical Spine.*—1. In the cervical region the commonest location for the focus of infection is in the bodies of the vertebræ. Suppuration forming on the anterior surface of the bodies accumulates at first between the bone and the prevertebral fascia. This is one of the causes of the retropharyngeal abscesses which so commonly occur in children. The direction of spread of the accumulation of pus is downward into the posterior mediastinal space of the thoracic cavity, or upward toward the base of the skull.

2. When the focus of infection develops in the lateral pedicles the pus accumulates on the anterior surface and comes forward in the cellular space in front of the anterior scalene muscles and behind the longus colli muscle; the abscess points in the posterior triangle of the neck being diverted in a lateral direction by the prevertebral fascia.

A similar course is followed by a focus developing on the anterior aspect of the transverse process. More commonly the abscess spreads in the cellular space between the anterior and middle or between the middle and posterior
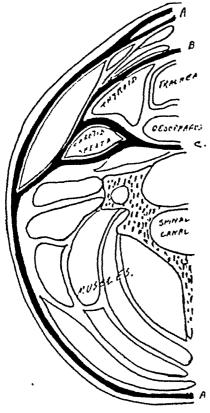


FIG. 2.—Hamisection of the neck; taken from Gray's Anatomy. The heavy lines indicate the main fascial planes. A-A, indicates the deep fascia; B, the pretracheal layer of the deep cervical fascia; C, the pre-vertebral layer of the deep cervical fascia. Compare with text.
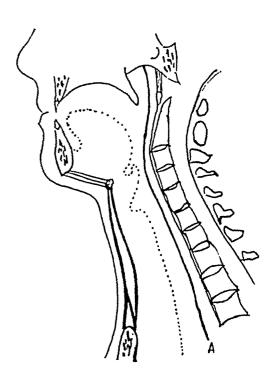
FIG. 3.—Vertical section of the neck and superior mediastinum taken from the *Army and Navy Manual of Surgery*. A is the prevertebral layer of the deep cervical fascia showing the path by which suppuration can spread into the mediastinum.

scalene muscles and points in the posterior triangle of the neck in the interval between the sterno-mastoid and trapezius muscles.

3. Abscesses developing from foci in the posterior aspects of the transverse processes, the laminæ, or the spinous processes, spread backward into the muscle spaces, lodging the various bundles on the posterior aspect of the neck. The commonest one, because of its position, develops in the thickness of the semi-spinalis colli muscle. Deep-seated abscesses are the rule which develop comparatively slowly and these when incised are reached far down in the tissues of the neck.

*AB. The Thoracic Spine.*—1. In the thoracic spine the commonest location for the foci is in that part of the spine posterior to the bodies. Suppuration developing on the anterior aspects of the pedicles and lateral processes,

in the lower half of the thorax, has the tendency to become enclosed in the fascial sheath of the iliopsoas muscles, or at least to be guided downward and outward along the tendinous origins of these muscles, and to appear clinically as iliopsoas abscesses. Further inward toward the median line the pus accumulates in the posterior mediastinum. Retropleural (extrapleural) abscesses have also been described.

2. Abscesses developing from foci in the posterior aspects of the transverse processes, the laminæ or the spinous processes, naturally spread backward in the depths of the spinal muscles lying in the two grooves between the bend of the ribs and the lateral-posterior aspects of the laminæ and spinous processes. Deep-seated abscesses are the rule.

3. Suppuration derived from foci in the bodies of the vertebræ which develop on their exterior surface accumulate in the cellular spaces of the posterior mediastinum. An acute mediastinitis follows which spreads rapidly upward and downward in this important space; or the process localizes as a mediastinal abscess. Occasionally the mediastinal abscesses discharge into neighboring lymphatic spaces of which the two following are the important ones:

*a.* A suppurative pleurisy results either from extension of the infection into the pleural sac or because of direct rupture of pus into the latter. It should be remembered that some of these suppurative pleurisies are undoubtedly of hematogenous origin and do not result from extension of the purulent focus in the neighboring spine.

*b.* A suppurative pericarditis results in ways similar to those attending the formation of a suppurative pleurisy.

4. Combinations of these three forms of pus accumulations have been described. Commonly a suppurative pericarditis is associated also with empyema on one or both sides.

*AC. The Lumbar Spine.*—1. Foci of osteomyelitis develop most commonly in the transverse processes and arches and in the spinous processes. Suppuration forming on the anterior surface of the transverse processes, or pedicles of the lumbar vertebræ, or on the anterior aspects of their bodies, occasionally localize themselves in these locations and form masses which can be palpated in the depths of the abdominal cavity. The suppurative processes extend forward and to either side in the following ways:

*a.* High up under the diaphragm on the right side the abscess spreads out under the diaphragm to form a subphrenic abscess. I remember one case in my own experience in which this happened. I have no notes of this case, however, and the details are very indistinct. On the left side the anatomical relations of the left lobe of the liver would make this more likely to become fused in the category of perinephritic abscesses.

*b.* On either side somewhat lower down the lateral spread of the suppurating process would appear clinically in the form of perinephritic abscesses.

Clinically sufficient spread of the abscess would cause difficulty in making

these fine anatomical distinctions and the probabilities are that all of these would be classified clinically as intra-abdominal abscesses.

2. Suppuration forming in relation to the posterior aspects of the arches and the transverse and spinous processes develop posteriorly in the depths of the spinal muscles in the small of the back.

Clinically and before these abscesses are opened they can be confused with those abscesses developing in the perinephritic space described in the preceding paragraphs which have come to the surface in the costo-vertebral angle. The differentiation should, however, be immediately made when the abscesses are opened.

3. Cases of peritonitis have been described complicating osteomyelitis of the lumbar vertebræ. The paths of infection include (*a*) extension by the lymphatic vessels into the peritoneal cavity; (*b*) frank rupture of an abscess into the peritoneal cavity; and (*c*) hematogenous (metastatic) infection of the peritoneal space.

*AD. The Sacrum and Coccyx.*—1. Suppuration derived from foci of osteomyelitis developing on the posterior aspect of the sacrum and coccyx appears clinically as localized abscesses over the sacrum or lower part of the spine and are practically subcutaneous affairs. These are very simple matters.

2. Suppuration developing from foci of osteomyelitis on the anterior aspect of the bones of the sacrum and coccyx develops in the hollow of the sacrum and spreads forward, laterally and downward. The following paths can be distinguished anatomically:

*a*. Suppuration developing from the lower segment of the sacrum or from the coccyx gathers in the interval between the coccyx and anus and lies beneath the levator ani muscle and the anal fascia. The pus spreads out of the pelvic cavity through the sacrosciatic notch and turns up in the depths of the gluteal muscles as gluteal abscesses. Or the pus burrows downward and appears clinically as a para-anal abscess.

*b*. Another variety develops above the line of attachment of the levator ani muscle. In the larger number of these a subperiosteal abscess develops on the inner aspect of the bone and between it and the iliacus muscle, and spreads upward to the crest of the ileum, where it appears as an extra-peritoneal abscess; some of these point above Poupart's ligament. In a lesser number abscesses form which spread forward and downward in the hollow of the sacrum and between the bone and the obturator and recto-vesical layers of the pelvic fascia. The pus gathers in the ischiorectal fossa and appears clinically as an ischiorectal abscess. A certain number of these spread upward, so that they cannot be palpated from below through the rectal canal, or at least are palpable with great difficulty. These are the cases which most frequently appear clinically as extremely obscure forms of general infection (pyemia, sepsis, etc.).

*Suppuration in the Interior of the Spinal Canal.*—Inflammatory changes in the interior of the spinal canal may be limited to an outpouring of inflammatory exudate and to a thickening of tissues lying between the dura mater

and the bone—a pachymeningitis externa. Suppuration, however, occurs very commonly and takes the form of an accumulation between the bone and spinal dura mater. This corresponds pathologically to a subperiosteal abscess. The accumulation may remain localized or may rupture through the dura and into the subarachnoid space; a spinal meningitis results. In this sense the latter is entirely independent of any form of meningitis which results from a hematogenous infection of the meninges during the course of any bacteriæmia which may be present. Cases have been described in which the extradural abscess has ruptured and escaped through one of the spinal foramina leading to the formation of a simple or complex abscess on the exterior of the spine in and between the muscle planes and bundles.

Compression of the cord leading eventually to a paraplegia may be entirely due to any of the causes suggested, *i.e.*, pachymeningitis externa or extradural abscess. Transverse and ascending forms of myelitis are described.

*(To be continued)*

# OSTEOPOROSIS OF THE HUMERUS FOLLOWING FRACTURE

## By Nicholas S. Ransohoff, M.D.

### of New York, N. Y.

FROM THE HOSPITAL FOR JOINT DISEASES

February 28, 1926, Mrs. B. E., age forty-one, presented herself at my office after having had a fracture seventeen days previously, in the middle third of her left humerus. While skiing at Lake Placid, the patient fell on her outstretched arm and heard a snap. Amidst a panicky crowd no first aid was administered, and the arm was allowed to swing in the winds unprotected for about two hours, until she arrived at a hospital.

Here an X-ray photograph was taken (Plate 1). An anæsthetic was given and the fracture was reduced. A practically perfect reduction was obtained and the fragments held in opposition by means of circular splints, in combination with a pyramidal cushion in the axilla.
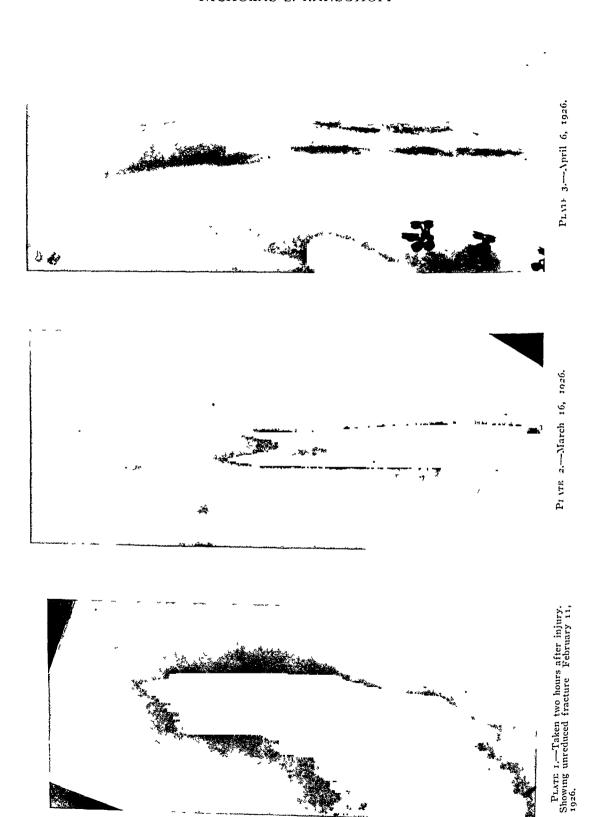
She recovered quite rapidly from the shock of the accident and came to New York, at which time I first saw her. The original splints were left intact for another few days, then, because she had rather more pain than would ordinarily be expected, diathermia was given through the fracture site. The electrodes were applied anteriorly and posteriorly. This gave so much relief that it was continued for several weeks. When removing the splints for this purpose, it was noticed that the arm had about the usual amount of swelling and a moderate amount of ecchyomosis, more marked on the inner side. There was definite tenderness over the point of fracture which was just about in the middle third of the humerus. Otherwise no abnormality was noticed.

At the end of several weeks, March 16, 1926, because palpation gave no evidence of union, a second X-ray picture (Plate 2) was taken to determine the amount of callus production. The X-ray report as given by Dr. Charles Gottlieb was: "Radiographic examination of Mrs. B. E. shows an oblique fracture through the left humerus, somewhat above its midpoint. . . . There is no evidence of callus formation or union." However, after the next set of films was taken it was noticed upon closer study of this first one that some structural change was taking place in the distal fragment. This showed itself as a peculiar mottling of the bone more marked distally, which, for want of a better term, we shall call "osteoporosis". The corticalis was well marked and had a very slightly honey-combed or moth-eaten appearance. There seemed to be no periosteal reaction whatever. The proximal fragment showed somewhat the same appearance at its distal end.

April 6, 1926, a third set of radiographs were taken (Plate 3). These showed what Doctor Gottlieb reported as "spotted atrophy". There was a very startling increase of those processes, which must have been in their incipiency in Plate 2. The bone looked like a cross section of sponge rubber. The honey-combing was markedly increased. The corticalis had lost a good deal of its definition. The areas which were most permeable to the X-rays were much more numerous and more definitely defined. There was a small amount of callus production. The rarefaction at the distal end of the proximal fragment was not as marked as that in the distal fragment, and the proximal end remained normal.

At the suggestion of Dr. Leo Mayer, who saw the patient in consultation at this time, the skull, right shoulder and humerus and left radius and ulna were then radiographed (Plate 5), and all the radiographs were reported negative. The X-ray plates of April 28 (Plates 4 and 5), three weeks later, show a still greater increase of the rarefying process throughout the distal fragment. Despite this increased atrophy, the site of
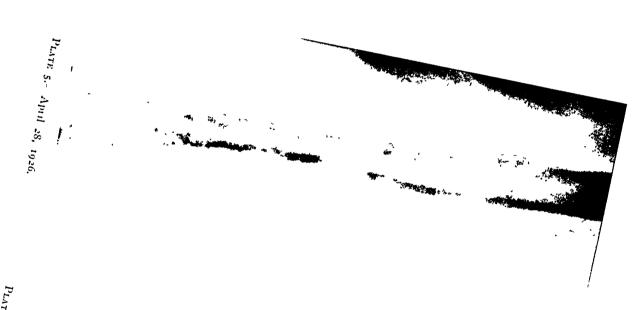
PLATE 3.—April 6, 1926.

PLATE 2.—March 16, 1926.

PLATE 1.—Taken two hours after injury. Showing unreduced fracture February 11, 1926.

PLATE 4.—April 28, 1926.

PLATE 5.—April 28, 1926.

PLATE 6.—April 9, 1926, radius and ulna. Note normal

the fracture was then enveloped in a well-developed callus. The atrophy in the distal extremity of the proximal fragment was well diminished.

The final plate (Plate 7), taken July 26, 1927, seventeen months after injury, shows a normally healed fracture of the humerus and complete disappearance of the pathological changes noted in the previous pictures.

After the third set of radiographs, inasmuch as we had never seen a condition which looked like this, we began to grope for the etiological factor. The Wassermann reaction was negative, with both alcoholic and cholestrinized antigens. The basal metabolism was within normal limits. The Goetsch test was negative. Blood chemistry as done by Doctor Bernhard, gave the following figures:

Urea Nitrogen .......................... 14.7
Creatinine ............................. 0.5
Sugar .................................. 0.80
Calcium (Mil per 100 c.c. of serum)....... 0.2
Magnesium (Mil per 100 c.c. of serum)... 2.4

All these figures were within normal limits. At the time that the patient was seen by Dr. Leo Mayer he suggested that the whole process might

PLATE 7.—July 26, 1927.

be explained on circulatory grounds, because the fracture was at approximately the point which Lexer has demonstrated as the entrance point of the nutrient artery of the humerus (Plate 8).

When further investigation of the blood supply of the humerus was made, it was found that Gray describes the nutrient artery as entering the bone on "the medial margin just below the attachment of the coraco-brachialis". The foramen points downward. Braus in his anatomy has a simple diagram which illustrates the course and development of the nutrient artery very well (Plate 9).

Upon investigation of the experimental work which has been done by so many on the healing of fractures, and the regeneration and the degeneration of bone, no really adequate explanation of what had occurred can be found, except that of Johnson. He shows by his experimental work that the diaphysis of the long bones is dependent for its nutrition upon three sets of vessels. These are in order of their importance: (1) Nutrient artery; (2) Metaphyseal vessels; (3) Periosteal vessels.

Johnson concludes: 1. "Nutrient vessels maintain viability throughout the medulla and supply the inner half of the cortex. Repair is active when the nutrient vessels are intact."

2. "Metaphyseal vessels maintain viability



PLATE 8.—The arteries of the humerus of a new-born child injected with mercury. (X-ray picture photographed from Lexer, Kuliga and Turk.)

throughout the medulla and inner half of the cortex, but repair is not as active as in the controls except close to the metaphyseal ends, being noticeably delayed in the middle region of the shaft."

3. "The periosteal system does not normally supply more than the outer half of the cortex, and is unable to afford effectual collateral supply to the medulla of the diaphysis under four weeks' time. The periosteal repair is relatively poor in the healing of cortical defects."

Based upon these observations a theory has been evolved as the explanation of the process which has taken place in this case: i.e., the site of fracture was in all probability at the nutrient foramen and therefore because there was no immobilization for fully two hours subsequent to the fracture, the nutrient artery must have been severely lacerated. Furthermore, because of this same trauma, the periosteum was badly lacerated. The metaphyseal vessels which Johnson says play so great a part in bone repair in young dogs are, in the adult, probably non-existent, or so small as to be unable to form an adequate anastomosis. It therefore seems fair to assume, that there has been very marked devitalization of the distal fragment due to interference with the blood supply. This probably has not been so great as to cause actual death of the bone, because on examining the X-ray plates of bone grafts, these grafts which surely die, do not present the picture we see in this case.

Whether or not there was some trophic nerve disturbance along with the circulatory disturbance, it is exceedingly difficult to say, but in view of the fact that there was no other evidence of any injury, it does not seem fair to assume this. The repair
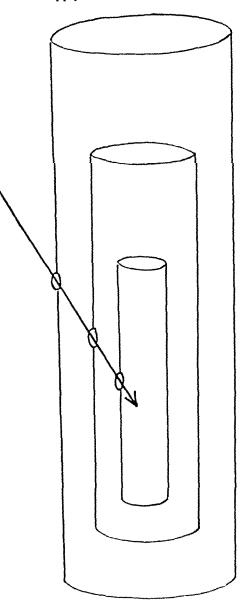
PLATE 9.—Direction of the Nutrient Canal of the Humerus. Three sizes of the growing humerus (placed one on top of the other). The relative positions of the nutrient artery is shown in this way. The proximal end grows faster than the distal. The nutrient foramen remains in the middle of the three different sizes. (Redrawn from Braus.)

was probably effected through an anastomosis between the periosteal vessels and the undamaged part of the nutrient artery which supplied the upper fragment.

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# ON THE TREATMENT OF THE SEPARATION OF THE LOWER EPIPHYSIS OF THE FEMUR [†]

## By Ernst Gold, M.D.

Of Vienna, Austria

THE most frequent separation of an epiphysis is at the lower end of the radius. In the material seen at the accident department of the Eiselsberg Clinic, in Vienna, 25.9 per cent. of the fractures of the lower end of the radius up to the eighteenth year were epiphyseal separations. On the contrary epiphyseal separation of the lower end of the humerus is a rare condition, while fractures of the humerus above the elbow are frequent in childhood. The most important epiphyseal separation of the lower extremity is that of the lower end of the femur. There are statistics (Brun, Kirmisson) which indicate them to be most frequent of all epiphyseal separations (28 per cent.).

The complete separation of the lower epiphysis of the femur is the most important from the point of view of the treatment, because it is often followed by premature



Fig 1 —Traumatic epiphyseal separation at lower end of femur, before reduction Lateral view

ossification of the epiphyseal line with cessation of the growth of the femur, especially when the accident happens to take place in early childhood. On the other hand, in a case of an incomplete dislocation of the lower epiphysis of the femur of a young boy of fourteen years we found, although the X-ray picture shows marked dislocation, an absolute functional-recovery. One year after injury the boy is the fastest runner in his class at school. Complete

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[†] Presentation made at a clinic held September 1, 1928, for the Travel Study Club of American Physicians.

Fig. 3.—Epiphyseal separation at lower end of femur, after reduction. Lateral view.



Fig. 2.—Epiphyseal separation at lower end of femur. Antero-posterior view.

dislocation of the lower epiphysis of the femur happens most frequently from a forcible twist of the leg, as when caught in a turning wheel. Epiphyseal separation is always associated with traumatic elevation and partial rupture of the periosteum.

Figures 1 and 2 are X-ray pictures of the knee of a boy of six years whose leg was thus caught by a wagon-wheel and forcibly twisted. Immediately after the injury he was taken into a country hospital where the case was diagnosed as ligamentous strain with bleeding within the joint, and it was treated with ice-bags. The practitioner felt sure that the injury of the knee-joint was severe, although the X-ray findings were apparently negative, and he suggested the possibility of epiphyseal separation. At the examination in the accident department four weeks after the original injury the injured leg was found to be three centimetres shorter than the other one with slight varus position, recurvation and marked lateral mobility of the knee. In the popliteal space a big bony prominence was felt. In the X-ray pictures, which were done in the station, there was a complete absence of the lower epiphysis of the femur from its normal position in the antero-posterior view. The lateral view showed the whole lower epiphysis of the femur to be separated from the diaphysis and dislocated forward into a position behind the patella, with the articulating surface turned toward the posterior surface of the patella and still attached by periosteum and new formed callus to the shaft. The boy was not able to bear any weight on the leg. At first I attempted to make a closed reduction without success. Then an open operation was resorted to. A longitudinal incision was made in the popliteal region along the course of the nerves and vessels which were isolated and retracted. The lower end of the diaphysis was freed from periosteum. The callus, uniting the epiphysis with the shaft, was separated subperiosteally. By this method I was able to avoid opening the knee-joint. In the bottom of the wound the separated epiphysis could be felt. An attempt was now made to reduce the epiphysis by means of direct pressure on the femur from behind forward while strong traction was made on the leg in flexed position. Only a partial reduction of the epiphysis was possible and this could not be maintained. It was decided therefore to attempt a gradual reduction by skeletal traction. A Steinmann-pin was driven through the head of the tibia and the leg was placed on Braun's frame (model of the Eiselsberg Clinic, which is adjustable to length as well as to amount of flexion) in semiflexion. The extension was then made in the line of the axis of the shaft of the femur. An X-ray picture showed the epiphysis gradually moving toward the position of reduction. Further reduction, however, could apparently not be executed without bringing the traction into the axis of the leg, the flexion of the knee being increased at the same time. A series of X-ray pictures on consecutive days showed a gradual movement of the epiphysis to complete reduction. Examination one year after reduction showed the boy to have regained a complete function with exception of a slight limitation of extension of the knee. He shows no symptoms of premature ossification of the epiphyseal line. The same method was applied in a fresh case of epiphyseal separation of the femur with perfect recovery. It is also applicable in the treatment of fractures above the elbow and has been used in several cases with complete success. This case of epiphyseal separation seems to be worthy to be reported because of the fact that a principle of treatment was used in the reduction which is not often seen.

# FRACTURES OF THE TIBIA INVOLVING THE KNEE*

## By Herbert S. Steuer, M.D.

### OF CLEVELAND, OHIO

FROM THE ANATOMICAL LABORATORY OF THE WESTERN RESERVE UNIVERSITY

## FREQUENCY AND CAUSE

In this era of the automobile the human knee is in a position of peculiar disadvantage, for it lies at the level of the bumper. Hence, fractures of the tibia near or involving the knee-joint are becoming more frequent and, in view of the consequent disability, more important.

Current text-book accounts, derived from the accidents of an earlier day (see literature cited), dwell upon indirect violence as the more common method of producing a fracture of the tibia involving the knee-joint. In the few articles recently published upon the subject (see literature cited) direct violence is accorded the premier rôle. Both views are correct for the particular date of their expression, but we must expect fractures from direct violence to claim our attention ever more insistently.
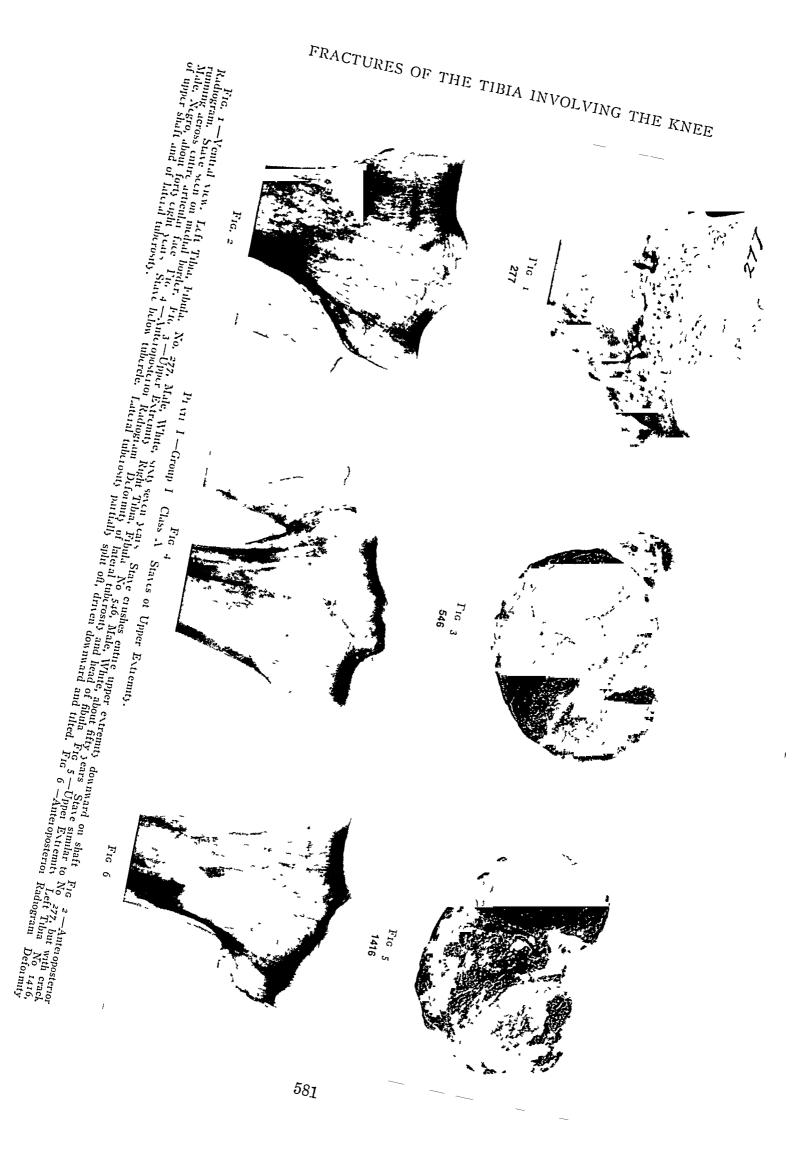
During the past fifteen years, among 1300 bodies of our deceased fellow-townsmen delivered to the Medical School and now housed as skeletons in the Hamann Museum are sixty-six fractured tibiæ. Thus fracture of the tibia occurs in 5 per cent. of a population by no means confined to paupers and vagrants. Our selection is a fair cross section of the Cleveland people, excepting the financially stable.

Almost half the tibiæ, thirty-two in fact, show fracture in the lower third. This is to be expected. Of the rest, eighteen involve the shaft, but do not enter the knee-joint. Thirteen of these fractures shattered the bone in its middle third, five in its upper. The remaining sixteen occur primarily in the upper articular surface itself. It is with this group that we are immediately concerned.

The examples at our disposal clearly arrange themselves into two series. The first, consisting of twelve specimens, involves either condyle or both, varies in extent of injury and in disorganization of the underlying tuberosity, but always results in deformity. It is rarely accompanied by synchronous fracture of any other bone. The second, comprising four examples, shows no such extensive injury, results in no recognizable deformity, and may be secondary to a more severe injury elsewhere in the body.

By the severity, localization and restriction of injury to the knee alone

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* This article was completed two days before Doctor Steuer's tragic death in line of duty on June 6, 1928. It has been for me an act of homage to the memory of my colleague to guide the article through the press. By it we may the better realize how promising a recruit has been lost to Surgery.

T. Wingate Todd.

FIG 1
277

FIG 2

FIG 3
546

FIG 4

FIG 5
1416

FIG 6

PLATE I —Group I    Class A    Status of Upper Extremity.

Fig. 1 —Ventral view. Left Tibia, Fibula. No. 277, Male, White, sixty seven years, State crushes entire upper extremity downward on shaft. Fig. 2 —Anteroposterior Radiogram. State similar to No. 277, but with crack running. State seen on medial border. Fig. 3 —Upper Extremity, Right Tibia. Deformity of lateral tuberosity, partially split off. Fig. 5 —Upper Extremity Left Tibia Male, across entire articular face. No. 546, Male, White, about fifty years State similar to No. 277, but with crack of upper shaft and of lateral tuberosity. Fig. 4 —Anteroposterior Radiogram Deformity of lateral tuberosity and head of fibula Fig. 6 —Anteroposterior Radiogram Male, Negro, about forty eight years. Fig. 4 —Anteroposterior Radiogram Lateral tuberosity partially split off, driven downward and tilted. No. 1416, Deformity. of upper shaft and of lateral tuberosity. State below tubercle.

it is apparent that the first group is the result of direct violence. In eight of these instances the left bone is injured. Upon similar analysis the injury of the second group is due either to a minor direct violence or to indirect violence, the chief injury being found in vertebral column, pelvis, upper



FIG. 7

688



FIG. 9

1534



FIG. 8



FIG. 10
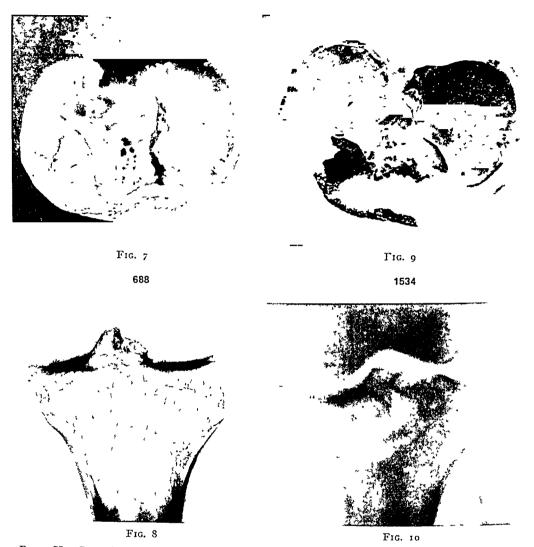
PLATE II.—Group I. Class B. Comminuted Fractures with Splitting Off and Impaction of Tuberosity.

FIG. 7.—Upper Extremity. Left Tibia. No. 688, Male, White, twenty-four years. Multiple cracking without real split of either tuberosity. FIG. 8.—Anteroposterior Radiogram. Clinically this would be negative. FIG. 9.—Upper Extremity. Left Tibia. No. 1534. Female, Negro, about forty-five years. Comminuted fracture with splitting off of medial tuberosity. Smaller fragments lost in maceration. Immediate death. FIG. 10.—Anteroposterior Radiogram. Taken soon after death. Shattering of upper extremity of tibia. This is a radiogram on admission, not of the macerated bone.

femur, or foot. A fracture of the calcaneus in one of our specimens occurs in the contralateral bone.

It is instructive to note that Crillovich, who described eleven cases of fracture of the lateral tibial condyle, cites eight as caused by direct violence. Clearly enough then, both from our own experience and from recently published work, direct violence is increasingly responsible for fracture of the upper end of the tibia.

Fig. 11
1322

Fig. 13
1382

Fig. 15
577

Fig. 12

Fig. 14

Fig. 16

Fig. 11.—Upper Extremity. Left Tibia. No. 1322. Male, White, fifty-four years. Comminuted fracture of both tuberosities with fracture of lateral tuberosity not seen.

Fig. 12.—Anteroposterior Radiogram. Evidence of deformity, especially of medial tuberosity. Arthritic deposits. Fig. 13.—Upper Extremity. Right Tibia, No. 1382, Male, White, sixty-three years. Comminuted fracture of both articular faces with tilt and impaction of medial tuberosity. Fig. 14.—Anteroposterior Radiogram. Male, White, about fifty years. Comminution of both tuberosities with tilting and impaction of both with splitting off and tilting of medial tuberosity. Tilting of lateral tuberosity. Fig. 15.—Ventral Aspect. Right Tibia, No. 577, Male, White, sixty-three years. Comminution of medial one. Fig. 16.—Lateral Radiogram. Note stave. Disorganization of lateral

PLATE III.—Group I. Class B. (Contd.)

Fig. 13.—Upper Extremity. Arthritic deposits. Right Tibia. No. 577, Anteroposterior Radiogram. Comminuted fracture of both condyles with splitting off and tilting of medial tuberosity.

*Physical Features.*—It is quite important to describe rather carefully the physical features of these fractures for they are often seen late, long after the fracture is healed. Indeed there may be no definite history of fracture, but only of considerable injury to the knee with swelling lasting for



FIG. 17
432

FIG. 19
1307



FIG. 18

FIG. 20
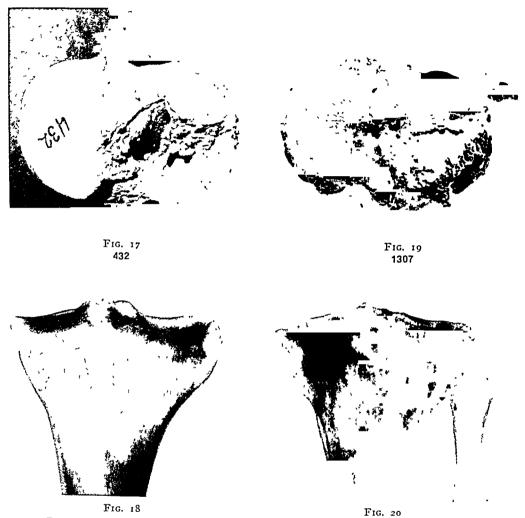
PLATE IV.—Group I. Class C. Depressed Fracture with Disorganization of Substance.

FIG. 17.—Upper Extremity. Left Tibia. No. 432. Male, White, fifty years. Depressed fracture of lateral condyle with disorganization of tuberosity. Note small impacted fragments. FIG. 18.—Antero-posterior Radiogram. Indication of disorganization of lateral tuberosity. FIG. 19.—Upper Extremity. Left Tibia, Fibula. No. 1307, Male, White, eighty-two years Depressed fracture of lateral condyle and disorganization of tuberosity. FIG. 20.—Anteroposterior Radiogram. Evidence of disorganization of lateral tuberosity.

weeks and permanent or increasing disability. There may even have been a röntgenogram equivocal or negative in its indications. We have seen such cases, coming under observation late, diagnosed and even operated upon for osteitis fibrosa, bone cyst, or tuberculosis. It is the need for more efficient differential diagnosis which prompts the attention given in this article toward the elucidation of an injury increasing in its frequency and importance.

For anatomical reasons the first group further separates itself into three phases of progressive severity. In the first of these (A) there is a stave of

the upper extremity of the tibia, cracking the articular surface more or less. We have three such specimens. In the second (B) there is a comminuted impacted fracture of the tuberosities with a Colles-like deformity. There are five of this class. The third class (C), with four specimens, is char-



FIG. 21
1503



FIG. 23
1591



FIG. 22



FIG. 24

PLATE V.
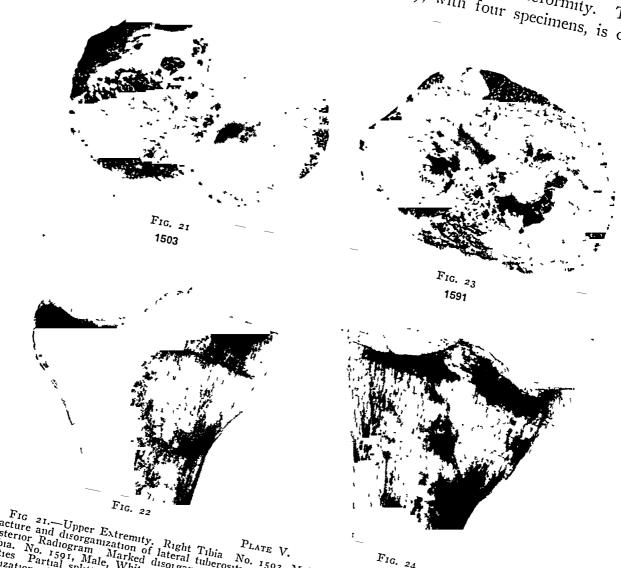
FIG 21.—Upper Extremity. Right Tibia No. 1503, Male, White, about sixty-five years. Depressed fracture and disorganization of lateral tuberosity. Some staving of upper extremity. FIG. 22 —Antero-posterior Radiogram. Marked disorganization of lateral tuberosity. FIG. 23 —Upper Extremity. Left Tibia. No. 1591, Male, White, sixty-two years. Depressed fracture and disorganization of both tuber-osities. Partial splitting off of lateral tuberosity. FIG. 24.—Anteroposterior Radiogram. Marked disor-ganization of both tuberosities.

acterized by a depressed fracture of the condyle and consequent disorganiza-tion of the substance of the tuberosity.

GROUP I.—Direct violence. CLASS A.—Staves of upper extremity with splitting and impaction of lateral tuberosity and some involvement of knee-joint. Three specimens.

No. 277. Male, white, sixty-nine years of age. Left tibia. Impacted crushing fracture canting the lateral condyle downward and laterally. The incomplete fracture through the intercondyloid area is well healed. No deposits of bone. The slight deform-ity appears on the radiogram.

No. 546. Male, white, about fifty years of age. Right tibia. Crushing impacted fracture similar to No. 277, but cracking both condyles and involving head of fibula. No consequent bone deposits. Deformity shown on radiogram.

No. 1416. Male, negro, about forty-eight years of age. Left tibia. Oblique fracture splitting off and impacting the lateral tuberosity so that the condyle faces backward and



FIG. 25
359



FIG. 27
1506



FIG. 26
821



FIG. 28
1284
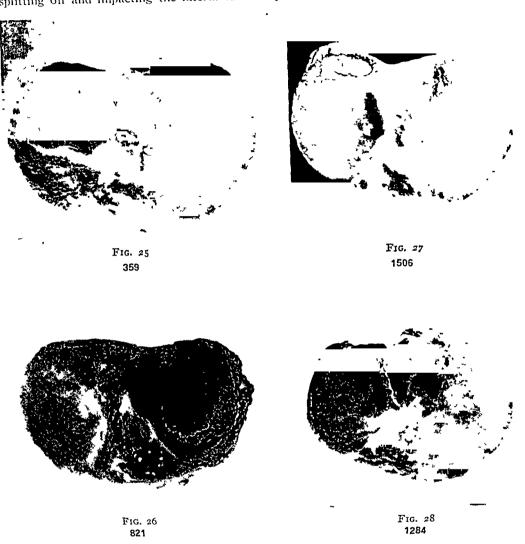
PLATE VI.—Group II. Minor Fractures.

FIG. 25.—Upper Extremity. Right Tibia. No 359, Male, White, sixty-three years Slight transverse crack of lateral condyle. FIG. 26 —Upper Extremity. Left Tibia No. 821, Male, White, seventy nine years Semicircular crack of lateral condyle FIG 27.—Upper Extremity. Right Tibia. No 1506, Male, White, fifty years. Localized comminuted fracture of dorsal part of lateral condyle. FIG 28 — Upper Extremity. Right Tibia. No. 1284, Male, White, about fifty years. Avulsion of eminentia intercondyloidea.

outward and is displaced downward. It is also deformed by bone deposits. There is an impacted fracture through the upper fourth of the shaft. Deformity admirably shown on radiogram.

In these three specimens the essential fracture is a crushing one staving the upper extremity into the shaft, cracking the condyle and tilting it into a position comparable with that of the radius in Colles's fracture. This class merges into Class B.

CLASS B.—*Comminuted fractures of tibial condyles.* Five specimens.

No. 688. Male, white, twenty-four years of age. Left tibia. Comminuted fracture of both condyles with downward driving and impaction, but no tilting of lateral tuberosity. Very similar to Class A, but without stave of entire upper extremity. No deposits of bone on articular face. Deformity indicated, but not well seen on radiogram.

No. 1534. Female, negro, about forty-five years of age. Left tibia. Comminution of ventral part of both condyles. Complicated by fatal internal injuries. Smaller fragments lost in maceration. Medial tuberosity split off, but not impacted. Condition well shown in radiogram of knee on admission.

No. 1322. Male, white, fifty-four years of age. Left tibia. Comminuted fracture both condyles. Medial tuberosity split off and impacted with Colles-like tilt of dorsal portion which is driven downward and faces inward and backward. No bone deposits on articular face. Deformity shown in radiogram.

No. 1382. Male, white, sixty-three years of age. Right tibia. Comminuted fracture of both condyles with Colles-like tilt and impaction of medial tuberosity which is driven downward and rotated to face somewhat medially. Some bone deposits on articular face which is also crippled by arthritic deposits. Lateral condyle of femur also split and impacted. Deformity shown in radiogram.

No. 577. Male, white, about fifty years of age. Right tibia. Comminuted fracture of lateral condyle only, complicating a stave of upper extremity including tubercle. Impaction of lateral tuberosity which is rotated to face outwards. This specimen shows characteristics of all three classes, but perhaps belongs most obviously to Class B. Deformity well shown in radiogram.

While No. 577 shows a stave like those of Class A the essential feature of it and of all the other four is a comminution of the articular surface, without consequent disorganization of the internal structure of the lateral tuberosity except in No. 577.

CLASS C.—*Fractures of articular face with disorganized structure of lateral tuberosity.* Four specimens.

No. 432. Male, white, fifty years of age. Left tibia. Comminuted fracture of articular face of lateral tuberosity alone with depression of fragments into substance of tuberosity. No splitting off or impaction of tuberosity or stave of upper extremity. Disorganized structure of lateral tuberosity shown faintly in radiogram.

No. 1307. Male, white, eighty-two years of age. Left tibia. Comminuted fracture of lateral articular surface with depression of fragments into substance of lateral tuberosity. No splitting off or impaction of tuberosity or stave of upper extremity. Disorganization of substance of lateral tuberosity shown in radiogram.

No. 1503. Male, white, about sixty-five years of age. Right tibia. Comminuted fracture of lateral articular face with depression of fragments into substance of tuberosity. No splitting off or impaction of lateral tuberosity or stave of upper extremity. Disorganization of substance shown in radiogram.

No. 1591. Male, white, sixty-two years of age. Left tibia. Comminuted fracture of entire articular surface with depression of fragments in substance of tuberosities. Complicated by split of lateral tuberosity, but without impaction of tuberosity or stave of upper extremity. Disorganization of substance shown on radiogram.

In these specimens the essential feature is a crushing of the fragments of the articular face into the substance of the tuberosity. These are the specimens which, when seen late, give rise to the diagnosis of osteitis fibrosa, bone cyst, or tuberculosis. The history of injury combined with the characteristic localized disorganization of substance should, however, clear the diagnosis.

There is not any hard and fast distinction between the three classes. Nor can there be postulated a corresponding difference in the violence of injury. The distinctions are accidental, but the cause is direct violence on the knee itself. Sometimes the force is expended on tibia alone, but it may also affect the femur.

Group II.—*Minor injuries.* Four specimens.

No. 359. Male, white, sixty-three years of age. Right tibia. Slight crack in lateral condyle. Similar slight crack in lateral condylar face of right femur. Radiogram negative.

No. 821. Male, white, seventy years of age. Left tibia. Slight crack in lateral condyle. Crushing fracture of right calcaneus. Radiogram of tibia negative.

No. 1506. Male, white, fifty years of age. Right tibia. Comminuted cracking dorsal part of lateral condyle. Medial condyle of right femur also cracked. Extensive fractures of pelvis. Dislocation of right hip. Fatal injuries. Radiogram of tibia negative.

No. 1284. Male, white, about fifty years of age. Right tibia. Cracking and separation of area of attachment of cruciate ligaments. No other fractures. Radiogram of tibia negative except for evidence of bone deposit.

These four specimens are evidently minor injuries of the knee-joint comparable with cracking of the articular surface of the patella found in quite a number of our skeletons. One was an injury limited to the knee-joint. Three were the result of indirect violence mainly expending itself in other areas. Clinically an exact diagnosis, immediate or late, would be impossible, but temporary swelling and disability nevertheless occur.

*Distribution.*—In Table I are given the numbers of skeletons examined for this type of fracture, arranged by sex and stock. The distribution is, however, erratic, for the table shows white males to be much more frequently injured than females or negroes. This is probably an accident of the series, but it is rather impressive to find that 1.2 per cent. of all our skeletons show fracture of the upper tibial extremity.

TABLE I.

|  | Total No. | Fractures | Percentage |
|---|---|---|---|
| White males | 854 | 14 | 1.6 |
| White females | 109 | 0 | 0.0 |
| Negro males | 340 | 1 | 0.3 |
| Negro females | 97 | 1 | 1.0 |
| Total | 1310 | 16 | 1.2 |

Table II details the location of the fracture. Our figures, allowing for the errors of random samples, follow closely those of Crillovich. Some 50 per cent. involve the lateral tuberosity alone and in 25 per cent. the entire upper extremity is injured.

TABLE II.

| Fracture | Steuer | Per cent. | Crillovich | Per cent. |
|---|---|---|---|---|
| Both tuberosities | 4 | 25.0 | 6 | 25.0 |
| Lateral tuberosity | 9 | 56.5 | 11 | 46.0 |
| Medial tuberosity | 2 | 12.5 | 4 | 16.5 |
| Eminentia intercondyloidea | 1 | 6.0 | 3 | 12.5 |
| Total | 16 | 100.0 | 24 | 100.0 |

# FRACTURES OF THE TIBIA INVOLVING THE KNEE

Table III is, perhaps, the most striking of all. From this one may infer that, under forty years, agility of the individual usually saves him from injury. The majority of such fractures occur between forty and sixty years. After sixty years the percentage diminishes. This can only mean that fracture in old age, when it occurs, is complicated by other injuries causing death, so that recent fractures are less likely to find their way into our collection. Among our sixteen examples only two died immediately.

| Age | No. of fractures | Per cent. of total |
|---|---|---|
| - 9 | 0 | 0 |
| 10-19 | 0 | 0 |
| 20-29 | 1 | 6 |
| 30-39 | 0 | 0 |
| 40-49 | 2 | 12 |
| 50-59 | 6 | 37 |
| 60-69 | 5 | 31 |
| 70-79 | 1 | 6 |
| 80-89 | 1 | 6 |

TABLE III.

*Differential Diagnosis.*—In old-standing cases like those of Group I, Class C, we have to make the diagnosis from bone abscess, osteitis fibrosa, bone cyst, tuberculosis, central sarcoma and secondary carcinoma. In the other two classes of Group I the diagnosis is straight-forward for a radiogram gives unequivocal evidence. In Group II the exact diagnosis would be merely accidental.

On a radiogram bone abscess is localized in the cancellous tissue. Osteitis fibrosa and cystic disease are usually more widely spread. Tuberculosis is accompanied by more widely distributed osteoporosis and, in a lesion of this extent, would not be confined to a single tuberosity. In our cases the patella is normal and the femur, if involved, shows a healed fracture. Central sarcoma causes an expansion of the upper extremity. Secondary carcinoma should be accompanied by signs of the primary lesion.

The diagnosis is not difficult if the history, clinical signs and radiograms are carefully studied.

## SUMMARY

1. Fracture of the upper extremity of the tibia is found in 1.2 per cent. of our skeletons.

2. It increases in frequency up to sixty years and most of our examples are found in skeletons between forty and sixty years. Thereafter, the percentage diminishes, probably because older people are less able to withstand the accident and its complications.

3. In 50 per cent. of our examples the lateral tuberosity is alone involved. In another 25 per cent. both tuberosities are injured. The remaining 25 per cent. includes fractures of medial tuberosity and intercondyloid eminence.

4. The fracture may be a relatively minor one, unrecognizable clinically

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and registered anatomically by a mere crack in the articular surface. This occurs in 25 per cent. of our examples and forms our Group II.

5. Of more extensive fractures, Group I, there are three successive phases or classes. The first is a stave of the entire upper extremity on the shaft. The second is a comminuted fracture with splitting off, and in some instances impaction also of one tuberosity. The third is a depressed fracture of one condyle with disorganization of the tuberosity, but without stave of extremity or splitting of tuberosity.

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# THE TREATMENT OF DIFFICULT FRACTURES OF BOTH BONES OF THE LEG

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Treatment of fractures of the shafts of the tibia and fibula is not infrequently difficult. Weight-bearing bones, which are of necessity surrounded by strong muscles, are subject to very definite distorting muscle pull. This distorting pull is stimulated by the fracture, which throws the muscles into spasm.

Fractures in the shafts of both bones of the leg are affected chiefly by the calf and peroneal groups of muscles, which, in addition to overriding, tend to cause very definitely an anterior angulation (calf group) and an internal angulation (peroneal group). The distorting pull of these muscle groups can be readily explained on the basis of their greater power and anatomical attachments.

Another definite factor which influences the treatment of weight-bearing bones is gravity, so that after muscular relaxation is obtained there is sagging of the fragments at the site of fractures. This holds true in fracture of both bones of the leg.

In the treatment of these fractures traction (skin and skeletal) and suspension by some type of splint are available. In the use of skin or skeletal traction there are several difficulties which may be encountered and which may be enumerated as follows:

(1) Distorting muscle pull with angulation and overriding which at times is difficult to overcome without adding a relatively heavy weight to the traction.

(2) Sagging of fragments is difficult to prevent by the usual method of suspension, such as with individual strips of cloth slung between the bars of the splint.

(3) Condition of the soft parts may be such that it is impossible to manipulate or apply skin traction.

The type of fracture plays an important part in reduction and the maintenance of that reduction.

To assist in overcoming these various difficulties the following method was devised by the author on the First Surgical Division at the New York Hospital.

This method makes use of skeletal traction by means of a Steinman pin through the os calcis, with fixation of the knee-joint by plaster-of-Paris splint at an angle to insure muscle relaxation, together with control of the other end of the fractured bones. It is as follows:

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The patient is put under ether anæsthesia and a Steinman pin passed through the centre of the os calcis under the proper aseptic precautions. A sterile dressing is then applied over the pin. Following this a metal strap is attached to the pin, made up of two Parham bands passed through each other. (Fig. 1.) An assistant makes traction on the metal strap sufficient to overcome the overriding of the fracture. No actual attempt is made to manipulate the fragments. The knee-joint is then flexed to an angle of ninety degrees while sheet cotton is applied from the upper one-third of the thigh down to the Steinman pin. Extra padding is placed over the patella. Several layers of plaster of Paris are then placed on the extremity. At this time a wire spade is incorporated in the plaster. The spade extends up to the knee and well out beyond the foot, being in the same general horizontal plane as the tibia and fibula. Several more layers of plaster are applied,
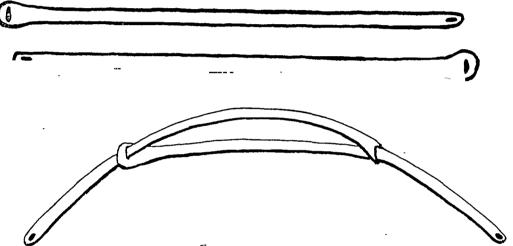


FIG. 1.—Diagram No. 1, showing two Parham bands passed through each other which are used as a stirrup on the Steinman pin.

sufficient to incorporate the wire spade and insure a firm splint. The plaster is allowed to harden and a pulley is attached to the end of the spade; a rope is attached to the pin and run through the pulley with a five-pound weight suspended from it. Weight may be increased or decreased or the pull may be changed in the lateral plane by simply shifting the pulley either side of the spade. Likewise, the direction of pull in the vertical plane may be shifted by placing the pulley below or above the end of the spade.

The patient is put to bed and the entire apparatus suspended from a Balkan frame. (Fig. 2.)

The leg is then X-rayed in twenty-four and forty-eight hours and again on the fifth day. Usually by the fifth day anatomical reduction has been accomplished. Then, with the traction still operating, cotton is placed about the foot and it is encased in plaster up to the original plaster. The slight gap between the two plaster splints is bridged by anterior and posterior moulded plaster splints which are in turn anchored to the circular splint by a few turns of plaster bandage. The fresh plaster is allowed to harden and in a few hours the Steinman pin is removed.

This gives a completed plaster-of-Paris spica extending from the upper one-third of the thigh down to and including the foot with the fractures reduced and held. (Fig. 3.) At the end of four weeks the plaster-of-Paris splint is bivalved, the fracture site tested, moulded plaster splints are then applied and the patient allowed up on crutches.

From necessity this method was devised to use on a patient, W. E., forty-seven years of age, who was admitted to the First Surgical Division, New York Hospital, May 28, 1926, with the history that ten days previous to admission he had fallen from a scaffold



FIG. 2.—Showing a plaster spica extending from upper thigh down to the ankle-joint with wire spade incorporated, and traction operating over the end of the wire spade. The entire apparatus is suspended from a Balkan frame.

and fractured both bones of the left leg. Manipulation and application of moulded splints was done. He was then admitted to the New York Hospital ten days after his accident with the original splints on. There was marked œdema of the foot and soft parts about the site of fracture. The skin over the lower one-half of the leg was covered by blebs. Under these blebs the tissues looked congested and angry. The fragments of the tibia were not in contact at all and there was internal angulation at the fracture site with outward displacement and external rotation of the distal fragments.

After admission an attempt at manipulation for better position resulted in a complete pulling off of the outer layers of skin over the lower one-half of the leg. Moulded plaster splints were again applied extending above the knee. Subsequent X-rays showed the position of the bone fragments not improved. Our röntgenologist reported a comminuted fracture of the left tibia at the junction of the lower and middle one-half, oblique fracture of the fibula at the same level, and in addition a second oblique fracture of the fibula up near its head.

Here was a case which could not be manipulated into position and due to the condition of the soft parts, skin traction or open operation was impossible.

The above apparatus was placed on this patient and a very satisfactory reduction was obtained in forty-eight hours. The pin was removed and the spica completed at the end of five days. The original plaster was removed at the end of four weeks, and firm union at the fracture sites was found. Moulded plaster splints were then applied, the patient was allowed home on crutches on the thirty-second post-operative day and reported to the hospital at regular intervals. After ten weeks his splints were removed and patient very gradually began to bear weight on his leg.

He was able to return to his usual occupation at the end of five months, with solid union, good weight-bearing line and no shortening.



Fig. 3.—Showing the plaster spica completed, including the foot, with the Steinman pin removed and wire spade still remaining.

Since this original case we have treated four other cases of bad fractures of both bones on the First Surgical Division, and one other case from the Second Surgical Division.

CASE II.—J. O., fifteen years of age, metal worker, was admitted to the New York Hospital, October 9, 1926, giving the history of having been struck across the left leg by a piece of iron weighing 400 pounds. X-rays showed a comminuted fracture of the left tibia, middle one-third, with an accompanying oblique fracture of the fibula with angulation and overriding. Manipulation and application of splints were attempted with poor results. Two days later our special apparatus was applied. An excellent reduction was obtained. The pin was removed in twelve days in this case and the patient allowed home on crutches wearing the moulded plaster splints on his twenty-first post-operative day. At a three months' follow-up he showed solid union and excellent weight-bearing alignment without shortening. He was then doing light work and later reported to me that he was doing the same heavy labor.

CASE III.—J. M., laborer, fifty years of age, was admitted to the First Surgical Division, New York Hospital, having been struck and his left leg run over by an auto-

mobile. X-rays showed a spiral comminuted fracture at the junction of the middle and upper one-third of the tibia with an accompanying fracture of the fibula. There was angulation, overriding and displacement of one of comminuted fragments. Manipulation was attempted with poor results. Our apparatus was applied two days later. The Steinman pin was removed on the twelfth post-operative day, while the original spica was removed at the end of three weeks. He was then allowed up on crutches with moulded plaster splints applied. He was allowed home on his fifty-ninth post-operative day, the delay being due to a complication of decubitus over the patella from insufficient padding. At the end of three months union was not solid, but seemed firm enough to allow him to wear a walking caliper brace. At the end of five months union was solid enough to walk without the caliper brace, and at my six months' follow-up he was walking normally with solid union, excellent weight bearing, and no shortening.

CASE IV.—P. E., female, forty-three years of age, was admitted to the First Surgical Division, New York Hospital, May 23, 1927, with the history of having been struck down by a taxicab which ran over her right leg. She had a badly compounded fracture of the right tibia which proved to be spiral in type at the junction of the lower and middle one-third. A débridement was done and a Lane plate applied to the tibia. Eleven days later, the patient's temperature having been high for some time, the wound was inspected and found to be infected. The Lane plate was removed and a long period of suppuration followed with a loss of considerable substance. In the meantime, due to dressing and handling of the leg, the fragments of both bones had been badly disarranged. Our apparatus was then applied one month following the removal of the Lane plate, with a window cut in the plaster for dressings. Following this, dressings and manipulations were far less painful to the patient. The fragments were found to pull into good alignment, especially the fibula. The pin was removed nineteen days after it was inserted and moulded splints applied, but of course there was no union due to loss of bone substance in the tibia. This patient continued coming to the Out-Patient Department for dressings and much to our surprise slowly got union, although the leg continued to suppurate. The fibula united first, which allowed the tibia to gradually fill in some of the gap which had been lost by suppuration.

At follow-up one year from her accident this patient has a small discharging sinus which is so slight that she does not come to the clinic for dressings at all. There is apparently solid union without false motion. There is some backward bowing at the fracture site in the tibia, but she is able to get about with the aid of a cane and a walking caliper brace.

CASE V.—F. S., male, thirty-nine years of age, was admitted to the First Surgical Division, New York Hospital, November 11, 1927, giving the history that just previous to admission, while directing the unloading of a barge of lumber, a large 12 x 12, 130 feet long beam, fell on his right leg, breaking it. X-rays showed a badly comminuted spiral fracture of the tibia at the junction of the upper and middle one-third with a comminuted fracture of the fibula at the same level. Manipulation was attempted with poor results. Three days later our special apparatus was applied. The pin was removed in nine days and about one week later moulded plaster splints were applied extending above the knee-joint. He was allowed home on crutches three weeks after his injury.

The patient continued to return to the Out-Patient Department and after eight weeks union was found to be firm, so that a walking caliper leg brace was applied. At six months' follow-up the patient was able to walk without any apparatus, union was solid, weight-bearing line excellent, and there was one-fourth inch of shortening in the right tibia. The patient was doing his usual work.

CASE VI.—A man, thirty-five years of age, was admitted to the Second Surgical Division, New York Hospital, with a fracture of the middle one-third of both bones of the right leg. He was treated in the same manner as the preceding cases, with a very satisfactory result.

I feel that these six cases represent as difficult types as one may encounter in the treatment of such fractures. The result in all except Case III has been very good and all of them have returned to their previous occupations, or could have returned, with solid union, good weight-bearing axis and without appreciable shortening.

*Critical Comments.*—(1) The plaster of Paris as applied fixes the knee-joint at an angle of ninety degrees, which puts and keeps the powerful distorting calf group of muscles at rest. It also acts as a constant means of suspension after muscular relaxation is obtained, so that it is impossible for the bones to sag at the site of fracture.

(2) Reduction is obtained by a minimum pull (five pounds is usually sufficient) due to complete muscular relaxation.

(3) The patient is comfortable at all times as there is no shifting of fragments to cause him pain. Likewise, with the suspension of the entire apparatus he is able to move about the bed freely.

(4) The Steinman pin can be taken out very early to avoid any bone necrosis or relaxation of the ankle-joint, while reduction is maintained by the completed plaster splint.

(5) Counter traction is distributed over a wide area chiefly against the posterior surface of the lower two-thirds of the thigh.

(6) With the incorporation of the wire spade, traction and counter traction are obtained on one piece of compact apparatus, so that a complicated set of pulleys and splints is not necessary.

(7) Patient is not able to adjust his own apparatus.

This method is published as one which has been used only in a limited number of cases, but in cases which are sufficiently difficult of management as to test its merits. It has come up to our best expectations, and being based on sound mechanical principles aimed toward overcoming the two chief difficulties in the treatment of fractures of weight-bearing bones (namely, distorting muscular action and gravity) it should continue to give good results.

For anyone desiring to use this method I would recommend fixation of the knee-joint at ninety degrees, with five- to eight-pounds' traction, removal of the Steinman pin and completion of the splint, on an average, after five days, with the removal of the original splint and application of moulded splints at the end of three to four weeks. Further treatment, such as allowing the patient a walking caliper leg brace, etc., should be carried out as indicated.

# VALUE OF CLOSING COMPOUND FRACTURES BY SKIN PLASTIC

## By John E. Cannaday, M.D.

of Charleston, W. Va.

The advantages of early closure of a compound fracture are obvious. Many hospital days, suffering, deformities and lives are saved. Aseptic and antiseptic first aid methods are desirable. Our custom has been to apply a gauze pad, wet with tincture of iodine, mercurochrome, or picric acid solution. The limb is immobilized, the patient is sent to the hospital. If he is not in a state of shock the wound is carefully débrided and disinfected. This is done with a scrupulously careful technic, quite as much as if the intent were to open the abdominal cavity. After débriding the wound, removing grossly contused and contaminated tissue, and freshening the skin edges by paring off a narrow strip all the way around, the wound edges are sutured most carefully and should be very neatly and precisely approximated. Great pains are taken not to invert the edges, but rather to bring them together pointing upward, like the apex of an inverted "V".

*Plastic Methods.*—In event there is such a loss of substance or œdema that the edges cannot be brought together by usual methods, long, liberating incisions may be made some distance away, in order that the skin edges may be brought together over the exposed bone without undue tension. It is advisable, as a rule, that such liberating incisions be carried through the outer fascial covering of the muscles. We follow this method in order to provide for an improved circulation and to lessen the likelihood of long-standing œdema. If advisable, this work can be done under local anæsthesia. The patient is always given a prophylactic injection of antitetanic serum. The treatment outlined is routine with myself and my surgical associate, Dr. E. B. Henson, at the Charleston General Hospital. In more than one hundred cases of compound fracture treated by early skin closure, primary union was obtained in more than 90 per cent. of the cases.

The following illustrative cases are cited:

Case I.—A woman, sixty-eight years of age, in crossing a dusty road in midsummer, was knocked down by a car, receiving a compound fracture of the tibia and a simple fracture of the fibula. The tibia broke through the skin and protruded for at least two inches. She was taken to a nearby hospital and I was called to see her shortly thereafter. X-ray showed considerable comminution and overriding of the broken bones. Inasmuch as her general condition was fair, she was at once given ether anæsthesia and the wound disinfected as thoroughly as possible with fresh tincture of iodine, the badly lacerated and traumatized tissues were débrided, a portion of the grossly contaminated bone was pared away with a rongeur. The wound was carefully closed with silkworm-gut sutures. These were placed close together, not over one-fourth inch apart, and were allowed to remain in for approximately two weeks. Primary union took place. Bony union was delayed, but finally took place.

Case II.—A mine foreman was sent to me at the Charleston General Hospital. This man was unwell at the time of his injury, his trouble having been diagnosed as pulmonary tuberculosis of a chronic type. He had a bad productive cough and had had the same for many months. He suffered frequently from severe pains in his chest. He was the victim of a slate fall and, when looked over, was found to have a simple fracture of the left radius, one of the left femur, and a very bad compound fracture involving both tibia and fibula of the right leg. There was considerable destruction and loss of tissue over the tibia at the point of fracture. This man was



Fig. 1.—Compound Fracture of Tibia with Extensive Exposure of Bone at Point of Fracture.

Fig. 2.—Showing Liberating Lateral Skin Incisions, Allowing Suture of Skin Wound Over Point of Fracture.

suffering great pain and was in a state of most profound shock. Cold perspiration, rapid, weak pulse, running 120 to 130 per minute. His general condition was so poor, even at that time, that his teeth were covered with sordes and his gums showed the presence of a severe form of pyorrhœa. He looked to be almost moribund. Splints were applied and the patient was put to bed. He was treated for shock. Glucose solution was given intravenously and hot water bags applied. Over the compound fracture was applied a dressing of gauze and cotton, wet with a two per cent. solution of mercurochrome.

The shock was severe and persistent. However, the next day the patient showed some improvement. At this time he was given 1500 units of antitetanic serum; still his condition continued poor. Three days later at noon, assisted by the resident physician on the traumatic service, I first débrided and then closed this compound fracture. The operation was done in the patient's room without moving him from his bed. The work was done under novocaine anæsthesia. Partly owing to loss of substance and partly

owing to swelling, large liberating incisions had to be made on either side of the leg. The fracture of the tibia was essentially a transverse one, and as the relative position of the ends was not good, it was improved by use of a bone skid. The wound caused by the original injury was snugly closed. This brought healthy skin over all of the exposed bone. The lateral liberating incisions on either side of the leg were approximately four inches in length and left a hiatus as much as an inch and a half in width at certain points.

For fear that these gaps in the skin might become grossly infected, they were treated with Carrel-Dakin solution for forty-eight hours. After that every three hours for a week. From this time on his granulating areas were dressed every other day with five per cent. balsam of peru in castor oil.

He stood the operation very well and had a fairly smooth convalescence. Most of the sutures were removed at the end of the second week. A few of them were allowed to remain for a few days longer for fear that there might not be firm union.

One month after injury this man's leg, so far as the skin is concerned, was so perfectly healed that it was hard to find the scar where his original injury was received. The liberating incisions on the side of the leg showed a smooth scar a little over one-fourth inch in width.

The leg is not swollen, the bony alignment is fair, and there is fibrous union. The man's chest condition has improved. Probably the rest in bed has helped that. At the end of the second month there was firm bony union.

CASE III.—Compound fracture of tibia and simple fracture of fibula; duration eight hours; wound disinfected, débrided and sutured, unfortunately under more tension than was desirable. Stay sutures were of silkworm gut placed quite close together. The site of the fracture had undergone partial healing so that healthy granulation tissue covered the bone; later, skin grafting was resorted to, the bony union was primary in spite of the fact that the skin did not hold. The protection afforded by the skin gave time for the building of a defensive wall at the seat of fracture.

## CONCLUSIONS

After a rather extended experience with the methods above described we have found that the results are immeasurably better than when treated by the open method. The application of ordinary plastic methods serves to cover and protect the bone at the site of fracture and to prevent not only prolonged invalidism, but deformity and the formation of dense scar tissues directly over the bone. Such tissue breaks down easily and is always a menace.

# THE TREATMENT OF FRACTURES OF THE CLAVICLE

## A STUDY OF 422 CASES OBSERVED IN THE OUT-PATIENT DEPARTMENT OF THE ROOSEVELT HOSPITAL OF THE CITY OF NEW YORK

### BY CHARLES W. LESTER, M.D.

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FRACTURE of the clavicle is one of the most common fractures that comes to treatment, being second only to Colles's fracture in its incidence. So much has been written regarding its treatment that Kreisinger, writing in 1927, found descriptions of over two hundred devices for its treatment. Most of these come under the head of reducing dressings; *i.e.*, dressings designed to reduce the fragments or to hold them in alignment. Yet nearly all authors on the subject from Hippocrates to date admit that reduction is almost impossible to maintain· and that a certain amount of deformity is to be expected. This deformity does not interfere with the function of the arm and tends to subside in time. With these facts in mind the value of complicated uncomfortable dressings is questionable. Certainly in cases of incomplete fracture, or fracture of the outer third without displacement, there can be no doubt that these dressings are more nuisance than they are worth, both to the surgeon and to the patient. The supporting dressing disregards the position of the fragments and merely aims to make the patient comfortable. It seems to be the logical dressing to use. To determine its value as compared with the reducing dressing a study of 422 cases treated in the Out-Patient Department of the Roosevelt Hospital between 1914 and 1927 was made. These cases were, of course, all ambulatory cases, and were treated by both reducing and supporting dressings.

A sling and binder or Velpeau bandage make no attempt at reducing the fracture or holding it reduced. They do support the weight of the arm and keep it from moving, thereby eliminating the two chief causes of pain and discomfort from the injury. Healing takes place as quickly with this form of dressing as with the others and the deformity is no greater as a study of the late results will show. It is, therefore, the dressing of choice in the great majority of cases.

Stimson, Scudder, Brewer, and other authors of text-books on fractures consider that a simple supporting dressing is sometimes the best form of treatment. Gibbon, quoting the observations made by Lucas-Championnière on jockeys, in whom fracture of the clavicle is a frequent injury, advises against any retentive dressing. He uses a simple figure-of-eight bandage between the shoulders with the arm supported by a sling and states that he has had excellent results when the sling alone was used. Colson, in reporting a large series of cases which occurred among children, advises the use of a simple sling entirely.

Figs. 1, 2, and 3.—Method of application of sling. The tapes are passed through rubber drainage tubes so that they will not cut the skin of the patient. A body binder not depicted here is used with this type of dressing.

The sling is easily applied. It should extend beyond the elbow and be drawn snugly so that it will lift and support the arm. The ends should not be tied back of the neck, but rather crossed over the back, carried around under the axillæ and tied over the sternum. (Figs. 1, 2, and 3.) The tapes should be broad or else they should be well padded so as to prevent cutting the skin. A rubber drainage tube with the tape of the sling threaded through it makes a good protection. The weight of the arm is then borne by the shoulders and not by the back of the neck. A simple swathe around arm and thorax keeps the arm from moving except within narrow limits. After a week or ten days the swathe may be dispensed with, the patient wearing the dressing inside the clothes which act as sufficient binder. In from two weeks to eighteen days the sling may be worn outside the clothes and discarded entirely in from three to four weeks. When worn outside the clothes the sling may be knotted behind the neck.

While the arm is inside the clothes a Velpeau bandage may be used. Some surgeons object to its use on the grounds that it increases the deformity. It was used in forty-seven cases in this series but no untoward deformity was noted at the end of the treatment.

One case in this series may be quoted as an example of the value of the sling and binder.

The patient was a man of twenty-one years who was thrown over the handlebars of his bicycle, striking the pavement on his shoulder. He sustained a comminuted fracture of the middle third of his clavicle which might be considered a double fracture. There were two principal lines of fracture which separated a middle fragment about three-quarters of an inch long. All fragments were overriding and piled on top of one another, the inner fragment being lowest and the outer fragment uppermost. In view of the marked deformity the Dwight modification of the Sayre dressing was applied with considerable tension. The dressing caused so much discomfort that the patient cut it down almost as soon as he left the hospital. He returned next day with the arm loosely supported by the diagonal strip of the dressing. The same type of dressing was reapplied and cut down about as promptly by the patient. On his third return, next day, it was decided to make no attempt at further reduction although the deformity was still in its original state. Accordingly he was treated by a sling and binder. Union took place and he was discharged thirty days after his injury with good function of the arm but with marked deformity and three-quarters inch narrowing of the injured shoulder. He was seen four years later. At that time the deformity was slight and the measurement of the width of the shoulders showed the injured side to be no narrower than the other. Function was complete. By simply keeping the arm at rest the fracture had united and in the course of time the reparative processes of the body had so far overcome the deformity as to make it unnoticeable without close inspection. This is not an isolated case as the other late results show similar cases, although not so striking.

Even without treatment fracture of the clavicle will heal although the resulting deformity is apt to be greater. Three such cases came to the clinic after the union had taken place and were given no treatment. One case would not keep any appliance on and amounts to an untreated case.

The number of times the various dressings were used in this series can be seen by referring to Table I.

TABLE I.

*Type of Dressing.*

A. Cases Completing Treatment

| Dressing | Complete | Incomplete | Comminuted |
|---|---|---|---|
| Dwight-Sayre | 125 | 29 | 4 |
| Sling and binder | 19 | 15 | 2 |
| Velpeau | 25 | 23 | |
| Figure-of-eight | 8 | 6 | |
| Cross | 2 | | |
| Harness | 1 | | |

B. Cases Abandoning Treatment After Ten Days or More

| | | |
|---|---|---|
| Dwight-Sayre | 30 | 4 |
| Sling and binder | 3 | 2 |
| Velpeau | 6 | 5 |

It will be seen that the Dwight modification of the Sayre dressing was the most popular. In considering this type of dressing it must be borne in mind that the patients were dispensary patients who were not seen more than twice a week and frequently only once a week. Hence, between dressings there was more or less slipping of the adhesive with consequent loss of the dressing's efficiency.

The average length of time required for the treatment was twenty-five days in the complete fractures and twenty days in the incomplete fractures. The dressing used seemed to make little difference in the time. The greatest time required was one hundred days. This was in the case of a man who applied to the hospital for treatment twelve weeks after his injury, during which time his arm had been kept immobilized by his local doctor. Another case in which the fracture was badly comminuted required three months. The remaining cases which needed more than six weeks to complete the treatment (eleven cases) had associated injuries to the shoulder which prolonged the treatment. Most of the cases needing more than a month received baking and massage. The others did not need it.

TABLE II.

*Site of Fracture.*

| | |
|---|---|
| Outer third | 65 |
| Middle third * | 250 |
| Inner third | 14 |
| Not stated | 93 |

*Results.*—In general it can be said that fracture of the clavicle will heal and give a good functional result. Even the four untreated cases had good function although the deformity was marked in three. The fourth was an incomplete fracture. So with the remainder of the cases in the series. Of

* Includes those of junction of middle and outer, and middle and inner thirds.

those cases which did not abandon treatment before four weeks there were only two with non-union.

One was in a man who remained under treatment eighty-four days. He had a four plus Wassermann reaction. At the time the last note was made on his record he had fibrous union and was getting antiluetic treatment. The other was in a girl of sixteen who abandoned treatment after thirty days. She also had fibrous union at the time. Attempts to trace both these cases have been unsuccessful.

TABLE III.

*Type of Fracture.*

Complete . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 241
Incomplete . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 112
Comminuted . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7
Not stated . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62

One hundred and eleven patients abandoned treatment before ten days and fifty abandoned treatment between ten days and three weeks. Such a large number of eloped cases is decidedly unusual in our other fracture cases and the reason for it is probably that they had no more symptoms rather than that they were displeased with the treatment. In many of our follow-up inquiries we came upon cases which had abandoned treatment because they thought they were all well and who had good results. One boy abandoned treatment after a week but returned a year later with a fracture of the other clavicle; he also abandoned treatment for the second fracture in a week and when seen in the follow-up had perfect function with the minimum of deformity. Undoubtedly some sought treatment elsewhere, either because they disliked us or because they lived too far away.

In the immediate results deformity is usual, especially in the complete fractures. Deformity also occurs in the incomplete fractures when there is angulation. In this series, however, marked deformity was noted in only fifty-three cases. Five of the seven comminuted fractures were discharged with marked deformity, one with moderate deformity and the other abandoned treatment. Three of the four untreated cases had marked deformity, the other being incomplete. Dressings designed to reduce the fracture as well as the simple supporting dressings were used. These cases are tabulated in Table IV. Apparently the deformity existing at the time treatment

TABLE IV.

*Marked Deformity at Discharge.*

| Dressing | Complete | Incomplete | Comminuted |
|---|---|---|---|
| Dwight-Sayre | 27 | 4 | 3 |
| Sling and binder * | 5 | 2 | 2 |
| Velreau | 4 | 1 | |
| No Treatment | 3 | | |
| Not stated† | 1 | | |

\* Two cases untreated for a week.
† One additional case in which type was not stated.

is instituted has more to do with the resulting deformity than the type of dressing used.

*Late Results.*—Follow-up inquiries were made only in those cases whose injury was subsequent to the summer of 1923. Clinic patients are inclined to be nomadic and usually move in less than five years leaving no address. There were sixty-one cases traced which were examined or reported by letter. The last case of the series was injured in February, 1927. Hence the cases in which the late results are given are all over twenty months old.

Function was complete in all of these cases, as would be expected from the immediate results. Two complained of a slight amount of pain at times but the pain was so slight that it did not interfere with the patients' activity. Thus from the point of view of function and comfort the results were nearly 100 per cent. perfect.

It is generally believed that the deformity resulting from a fracture of

TABLE V.
*Cases without Late Deformity.*

|  | Number of Cases | Type of Fracture | | | Dressing | |
|---|---|---|---|---|---|---|
|  |  | Complete | Incomplete | Comminuted | Supporting | Reducing |
| Adults............. | 11 | 8 | 1 | 2 | 7 | 4 |
| Children.......... | 43 | 27* | 13 | 0 | 29 | 14 |

the clavicle persists. The results in these cases indicate the opposite. Of the sixty-one cases only seven showed noticeable deformity. Those without deformity are from all classes; adults and children; complete, incomplete, and comminuted fractures. They were treated by supporting dressings as well as by dressings which strove to maintain reduction (Table V). Those who had late deformity have been tabulated individually. Four were in adults and three in children. In only three was the deformity marked. One of these

TABLE VI.
*Cases with Late Deformity.*

| Age | Type of Fracture | Dressing | Deformity | Remarks |
|---|---|---|---|---|
| 60 | Complete | Sling | Moderate | Three-quarter inch shortening; deformity hidden by fat. |
| 42 | Complete | None | Marked | Would tolerate no dressing. |
| 28 | Complete | Sayre | Marked | |
| 21 | Comminuted | Sling | Slight | Three-quarter inch shortening at discharge; none in late result. |
| 13 | Complete | Figure-of-eight | Slight | |
| 6 | Incomplete | Sling | Marked | Incomplete fracture followed by refracture, also incomplete, two weeks after discharge. |
| 5 | Complete | Sayre | Slight | |

* Three cases in which type of fracture was not stated.

was an untreated case. One was in a refracture through the previous line of fracture, both fracture and refracture being incomplete. The other case was treated by a dressing whose aim is to maintain reduction. These figures show forcibly that uncomfortable and intricate dressings designed to hold the fragments in alignment (whether they do or do not) are of no more value than a simple, comfortable, supporting dressing.

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# THE TREATMENT OF SUPRACONDYLAR FRACTURE OF THE HUMERUS

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In 1910 Ashhurst published a monograph on fracture about the Elbow. It marked a great change in the prognosis of fractures, which, to that time, were treated with the hope that the elbow would be restored to normal, but with the expectation that it would not. The secret of his success in the treatment of supracondylar fracture of the humerus rests upon two propositions: accurate reduction, and fixation in hyperflexion. The improved results obtained since that time by men following these principles have proved his teaching correct.

From an anatomical and clinical study of this fracture the following conclusions were drawn:

1. The carrying angle will be preserved if reduction is complete and the forearm is accurately superimposed in hyperflexion upon the humerus before the arm is brought across the chest.

2. The triceps is the only muscle vitally concerned in the reduction of the fragments; its pull must be overcome before alignment is possible; it will hold the reduced fragments in apposition when the elbow is hyperflexed.

3. "Volkman's Ischæmic Palsy" will occur less frequently when complete reduction has been effected.

Uncomplicated supracondylar fracture with the most common type of displacement, the lower fragment backward and upward and the upper fragment resting upon the anterior capsule of the elbow, will be considered. Assuming that the diagnosis has been made and confirmed röntgenologically, replacement should follow at once. Unless there is marked hæmorrhage in the tissues swelling should not prevent immediate reduction. General anæsthetic is desirable. To watch fluoroscopically the fragments return to their proper position is very reassuring.

Two movements are essential: traction and hyperflexion. The assistant holds the humerus while the surgeon grasps the wrist with one hand and the lower fragment with the other hand, placing his fingers around the condyles and his thumb against the lower end of the upper fragment. With steady, firm traction on the extended forearm, and backward pressure with the thumb upon the upper fragment, the fractured surfaces are guided into alignment. If the lower fragment will not come into position it is because enough traction is not made. Having apposed the surfaces, the forearm is hyperflexed and accurately superimposed upon the humerus. Hyperflexion is defined by Ashhurst as that degree of flexion which can be obtained without shutting off the radial pulse. Because a valgus deformity at the elbow

is less deforming than a varus, some prefer to overcorrect by bringing the little finger in line with the great tuberosity of the humerus.

The forearm is then dressed in the flexed position and rotated medially across the chest. In hyperflexion the fragments are firmly locked and cannot be thrown out of position. If the forearm is brought across the chest before hyperflexion is complete the lower fragment will tend to rotate upon the upper, to separate laterally and override medially. Healing in this position will result in a valgus or gunstock deformity. (Fig. 1.)
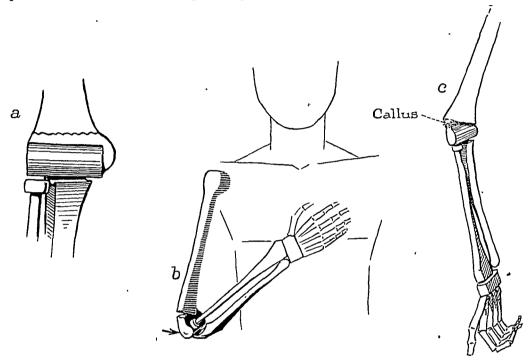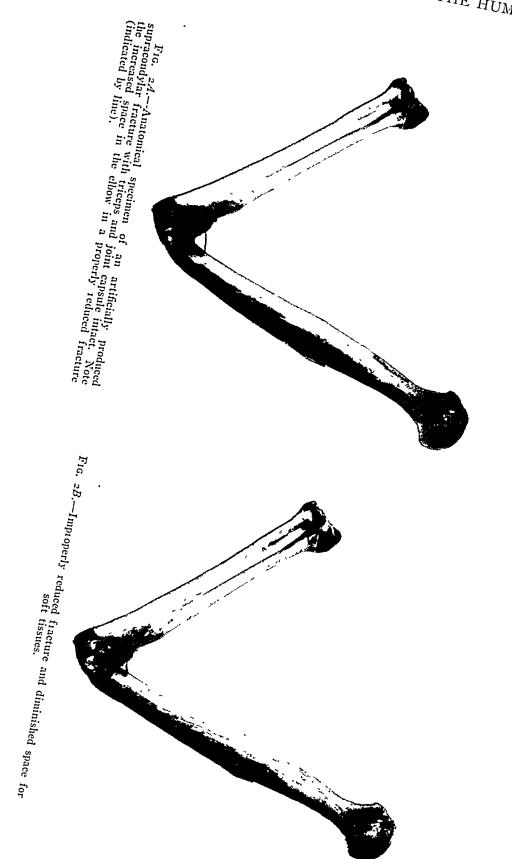


FIG. 1.—*a*—Schematic drawing of the elbow to illustrate mechanics. *b*—Medial overriding, lateral separation or rotation of the fragments upon each other as a result of bringing the forearm across the chest before the fragments are locked in hyperflexion. *c*—Healing in this position resulting in a valgus or gun-stock deformity.

Complete reduction allows the forearm to be flexed to an acute angle without using force. The space between the humerus and the forearm is greater when the lower fragment is brought sufficiently far anterior. (Fig. 2.) In most cases there will be ample room in hyperflexion for the soft tissues and the swelling incidental to the injury without danger to the blood supply. Vascular disturbance (Volkman's Ischæmic Palsy) is apt to follow when the forearm with the lower fragment improperly reduced is forced into position against the resistance of diminished space.

There is in our museum of pathology the amputated forearm of a boy who suffered a supracondylar fracture of the humerus. The arm had been set in acute hyperflexion and the boy sent home. When the doctor called the following morning the arm and hand were black and lifeless. If the patient cannot be under competent observation following the fixation of the fracture in hyperflexion, it will be safer to place the arm in a right angle position. It is only fair to state that some competent surgeons advocate

FIG. 2A.—Anatomical specimen of an artificially produced supracondylar fracture with triceps and joint capsule intact. Note the increased space in the elbow in a properly reduced fracture (indicated by line).

FIG. 2B.—Improperly reduced fracture and diminished space for soft tissues.
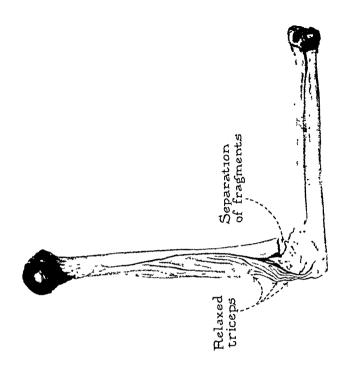
Fig. 3B.—At a right angle the triceps, in an anatomical specimen, is relaxed; in the living, is partially contracted and tends to separate the fragments, pulling the lower upward and backward.
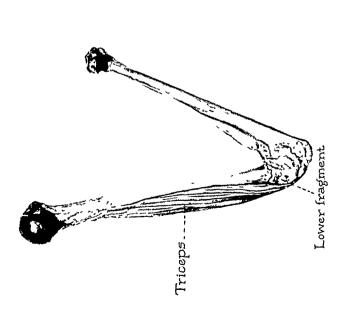


Fig. 3A.—In hyperflexion the triceps is tense and the fragments are interlocked

right angle fixation as a general rule, and report good results. We advocate hyperflexion as a rule; but certainly partial limitation of motion with a valgus or varus deformity is nothing compared with the loss of an arm or an arm crippled by vascular disturbances as a result of over-zealous hyperflexion.

The triceps muscle, inserted into the tip of the olecranon, contracts and draws the lower fragment upward and backward. Before reduction can be executed its pull must be overcome by traction. In the position of hyperflexion (Fig. 3 *A*) it becomes tense and holds the fragments interlocked. It also prevents slipping when tense as a firm posterior moulded splint. The danger of dressing these fractures at a right angle is apparent. (Fig. 3 *B*.) In this position the surfaces are not firmly apposed because the muscle is not tense, and the direction of force is not to appose, but rather to separate the fragments. This is especially true because the line of fracture in most instances runs backward and upward.

It makes little difference how the properly reduced fracture is held in hyperflexion. Ashhurst advises a simple bandage. Scudder suggests adhesive fixation. Lund devised an ingenious bandage about the body. We follow the teaching of Kellogg Speed and use a posterior moulded plaster splint. This is comfortable and holds the arm firmly where it is placed. It has the added advantage of holding the hand in supination when this is desired.

The routine post-operative care of the average supracondylar fracture is made simple. The child is kept in the hospital for twenty-four hours under very careful observation. The dressing is adjusted if necessary, and the patient dismissed with the instruction to return bi-weekly. The dressing is removed each time, the arm inspected and powdered, and the patient asked to move the arm as much as he can. This will usually be not more than five to ten degrees. At the end of two weeks the splint is bent to a right angle and the arm lowered to that position. Upon the next two visits it is made certain that hyperflexion is possible. The posterior right angle splint is replaced. At the end of the third week the splint is discarded and the arm supported in a sling. All dressings are removed at the end of the fourth week, and instructions are given the patient or its parents to soak the arm in hot water twice a day and to move the arm actively. If complete extension is not possible at the end of the fifth week weight carrying is begun. Carrying a small pail in which a little more sand is put each day stimulates the interest and coöperation of the child.

# TRANSACTIONS

OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 28, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

## TROPHIC ULCERS OF THE FOOT

DR. ABRAHAM HYMAN presented a boy, fifteen years of age, who was admitted to Mount Sinai Hospital November 24, 1926. He had first noticed several blisters on the sole of his left foot some four months previously, which he had attributed to narrow shoes. Infection of these blisters had followed, causing swelling and pain in the foot. Two months later the swollen area had ruptured about two centimetres below the small toe. He entered the Flushing Hospital, where for seven weeks conservative treatment, consisting chiefly in the application of wet dressings and baking of the foot, was carried out without improvement. Two weeks after his discharge from that hospital he developed a suppurating sinus at the site of the ulcer, and was then sent to Mount Sinai Hospital.

At Mount Sinai he gave a further history of pain in the left leg, spine and shoulders for three months, with a loss of fifteen pounds in weight. For the two days prior to admission there had been tenderness in the inguinal glands on the right side. With the exception of the above, the past history was irrelevant, the only two items of importance being a tonsillectomy and appendectomy respectively two and one-half years previous to the present illness.

He was a poorly nourished boy, with teeth discolored and pyorrhœic. On the plantar aspect of the left foot, at the head of the fifth metatarsal bone, a small, irregular opening in the skin presented, moderately tender and with necrotic tissue at its base. There was no evidence of inflammation around this area. In the corresponding region of the right foot a portion of the skin about the size of a twenty-five-cent piece was found to be thickened and hard, having the appearance of a callus. In the centre of this area was a small opening about one millimetre by two millimetres in size, and the region around this was markedly tender without, however, showing any sign of inflammation. The patient's temperature on admission was 102, but dropped to normal in a few days. Examination of the urine was negative.

X-ray of the feet revealed a thickening of the periosteum of the left fifth metatarsal with no evidence of bone destruction. The picture gave the impression of a partial dislocation of the metaphalangeal joint of this toe. Neurological examination was negative except for a right facial asymmetry. There were no sensory disturbances. His condition improved under treatment so that he was discharged from the hospital December 3, 1926.

Three weeks after his discharge he was again admitted to the hospital, having in the interim been under treatment in the dispensary. He now complained of swelling of the left foot, with pain more marked at night than by day. There was constant discharge from the sinus on the left foot and from an ulcer which had formed at the site of the callus on the right foot. On examination a red ulcerated area about the size of a twenty-five-cent piece over the head of the fifth metatarsal of the left foot was disclosed, with some

induration at the periphery and tenderness all around this spot. X-ray of the spine was negative; that of the left foot showed a periosteal thickening of the fifth metatarsal similar to the condition previously noted, with an area of bone destruction at the head.

*Operation.*—December 28 the little toe of the left foot was amputated at the metatarsophalangeal joint. Pathological examination of the specimen removed showed acute inflammation of the soft parts with fibrous atrophy of the bone. Neurological findings failed to demonstrate any signs pointing to syringomyelia or any other organic disease of the central nervous system.

When he left the hospital on January 13 there was a small, discharging sinus which at the time he was next seen in the return clinic, February 2, was closed. May 16 an X-ray of the feet showed no abnormality of the remainder of the metatarsal bones. There was, however, an irregular area of destruction on the upper anterior surface of the os calcis which gave the appearance of a small, localized osteomyelitis.

July 7, 1927, he was readmitted to Mount Sinai Hospital complaining of swelling and pain in the left foot. The big toe was reddened in appearance, but not tender. On the plantar surface of the proximal phalanx of the great toe a third punched-out ulcer about one centimetre in diameter had formed, which was discharging pus. A small scar presented on the lateral surface of the foot, near the point of removal of the fifth toe. His general condition was unchanged. There was good pulsation in the dorsalis pedis on both sides. Typhoid vaccine injections were given intravenously, the dosage July 7 being five millions, which was doubled on the 15th. The local condition seemed to improve under this treatment, and a third inoculation of twenty-five millions was given on the 22nd, followed by a fourth of forty millions on the 24th of the month. Subsequent to these inoculations the ulcer of the toe healed entirely.

July 21, at the time of his discharge from the hospital, an X-ray of the left foot showed rarefaction at the head of the second and third metatarsal bones. The Wassermann was negative, as was the urinalysis; the blood count was normal.

After leaving the hospital he was well for a time with the exception of a few attacks of pain in both feet, associated with fever, chills, vomiting, and headaches, and pain in the muscles of the lower extremities occasionally. March 9, 1928, he was admitted for a fourth time complaining of almost constant pain in the feet. The ulcers, which had healed over under the typhoid vaccine, had reopened of late. The general physical condition remained unchanged.

The ulcers on the plantar surface of both large toes were each about the size of a twenty-five-cent piece, and there was a smaller ulcerated area in the region of the small toe of the right foot. No neurological signs of sufficient importance to warrant a diagnosis of disease of the central nervous system could be obtained. There was pulsation in the large vessels of both feet. The oscillometer showed equal and normal circulation on both sides.

Typhoid vaccine was again administered intravenously, with the result that the ulcer on the left foot healed in a short time, and that on the right foot was almost healed following the last injection of one hundred and fifty millions. Examination of the throat and nasal sinuses was negative. Dental examination revealed a few infected teeth, which were extracted at once. He was discharged from the hospital April 2, 1928.

The patient was next seen April 18, at the time of his fifth admission to the hospital. Following extraction of the infected teeth he had developed a submaxillary adenitis. Examination of the feet showed the ulcers almost

healed, there being only a slight discharge from a superficial ulceration on the left foot. The Quickenstedt test showed some evidence of a partial block in the spinal canal. Both the neurological surgeon and the dermatologist on consultation diagnosed the condition as trophic ulcers of the feet.

July 5 of this year he was admitted to Mount Sinai Hospital for a sixth time. On examination the condition of the feet was found unchanged. The ulcers had reopened, there being two on the plantar surface of the left foot and one in a corresponding site of the right foot. He also complained of dull headaches, without, however, any blurring of vision. X-ray of the right foot taken July 14 showed a periosteal thickening of the entire shaft of the fifth metatarsal, with deformity of the head.

July 17 a left peri-arterial sympathectomy was done. The femoral artery was exposed in Scarpa's triangle. A large inflammatory gland was found overlying the artery, and this was excised. The femoral artery was denuded for a distance of about two inches above and below the entrance of the profunda. On the second post-operative day it was noted that the left foot felt warmer than the right, and the callus on the sole of the foot was less painful and softer, both of which conditions obtained in an increasing degree on the fourth day. Aside from a slight infection of the wound which cleared up with wet dressings there were no complications.

For a time there was improvement in the local condition of the left foot, the ulcers becoming more and more superficial; but a few weeks after leaving the hospital the ulcers reopened and the condition reverted to that previous to operation. August 25 he again entered the hospital because of lymphangitis of the left leg, which cleared up under wet dressings. The status at the last examination, November 23, was as follows: One ulcer on the sole of the right foot; two on the sole of the left foot; slight pain experienced on walking.

This case presents a young man with trophic ulcers of both feet yet with no demonstrable neurologic or vascular organic disease to account for the condition. X-rays have on a number of occasions showed changes suggestive of Köhler's disease; but in the descriptions of that disease the reporter had been unable to find any mention of associated ulcers. In going over the X-rays of the spine it is to be noted that there is only a partial fusion of the fifth lumbar vertebra. The radiographers seem to attach little importance to this defect, which may, however, be of some significance.

Dr. WALTER M. BRICKNER called attention to the fact that the röntgenogram of the spine in Doctor Hyman's case showed a cleft in the arch of the fifth lumbar vertebra. To be sure such a cleft in the fifth lumbar, somewhat less often in the fourth lumbar or the first sacral arch, is a very common finding; in many cases it is, apparently, without any clinical significance. Nevertheless it is sometimes the only local objective finding in cases with symptoms of spina bifida occulta. In his published study of that disease (*American Journal of the Medical Sciences*, April, 1918, vol. clv) Doctor Brickner had said that we must recognize four groups: (1) Those with external signs (hypertrichosis, congenital lipoma, telangiectasis), with symptoms; (2) those with external signs, without symptoms. (3) Those without external signs, with symptoms. (4) Those without external signs, without symptoms. Doctor Hyman's case may very well be one of spina bifida occulta of the third group. Certainly, the recurring trophic ulcers with callous borders,

as presented and described, are quite like those seen with spina bifida. The failure, of all attempted therapy, and the apparent hopelessness of the condition, justify, in Doctor Brickner's opinion, an exploratory operation on the spine. In his series none of the cases operated on for spina bifida occulta suffered any ill effect. To be sure, such operations are not likely to be followed by brilliant results since there is usually an irremediable lesion in the cord. Sometimes, however, the release of caudal filaments adherent to the dural sac effects relief, and this might happen in Doctor Hyman's case. In one of the cases of spina bifida occulta operated on by Doctor Brickner the release of adherent caudal elements in the dural hernia was followed by healing of frequently recurring ulcers of the buttocks. In the course of subsequent years trophic ulcers and gangrene involved several of the toes, but ulcers on the buttocks never appeared again.

## ANURIA COMPLICATING FRACTURES OF THE EXTREMITIES

Dr. Abraham Hyman presented a boy, ten years of age, who was admitted to Mount Sinai Hospital, March 25, 1927, with a history of an automobile injury a few hours previously. Examination revealed a fracture of both femora in the middle third with displacement of the distal fragments mesially. The left elbow region showed a fracture through the lower end of the humerus with displacement outward of the lower fragment and, also, fracture of the internal condyle. Under open ether anæsthesia the fractures of the femora were reduced under fluoroscopic control, and a large plaster-of-Paris case applied. A röntgenogram taken the following day demonstrated that there was still some displacement of the fragments; the case was removed accordingly and on March 30 another case applied. For this purpose a second anæsthetic was administered. Both thighs were put up in abduction with partial flexion of the knee-joints. The elbow was put up in flexion.

From the time of his admission, March 25, until April 4 the patient passed normal amounts of urine which showed a faint trace of albumen, with a specific gravity of 1012; on one occasion a few granular casts were found. On April 4 there were two attacks of macroscopic hematuria. An examination of the fundi at this time showed them normal; the blood pressure was 150/100. April 5 the patient stopped voiding, and catheterization yielded only ten cubic centimetres of bloody urine. The next day the urinary output ceased entirely, vomiting ensued, the pulse became rapid and of very high tension, and the blood chemistry examination showed an urea of 67, nitrogen 113, uric acid 8.6, and creatin 3.1. The few drops of urine obtained were loaded with red blood cells, occasional white blood cells, and hyaline and granular casts.

Despite medication and diuresis there was absolutely no urinary output, and on the third day of his anuria, in view of the high blood chemistry and the clinical evidences of uræmia, it was decided to do a decapsulation. Under gas and oxygen anæsthesia both kidneys were exposed. The kidneys were not engorged or glaucomatous; if anything, they were paler than a normal kidney. Both kidneys were decapsulated and a small section of kidney parenchyma removed for histological examination.

The morning after the operation a blood chemistry examination showed that the figures had mounted, the urea being 82, nitrogen 131, uric acid 10, and creatin 3.4, with a carbon dioxide of 53. Within twenty-four hours following the operation the patient voided five ounces of urine. The next day the urinary output increased to twenty-four ounces and there was profuse

urinary drainage from both lumbar incisions which had been drained. The histological report on the specimen of kidney parenchyma removed was "slight tubular degeneration with cloudy swelling".

The urinary output steadily increased to forty-two ounces at the end of the third post-operative day, the nausea disappeared and the vomiting ceased. The blood pressure dropped from 150/100 to 115/65, and the blood chemistry figures gradually returned to normal. The wounds healed kindly, the urinary leakage ceasing within ten days. From this time on the convalescence was uneventful. The urinary examination now shows a normal specimen.

## ECTOPIC SUPERNUMERARY URETER OPENING INTO THE VAGINA

DR. ABRAHAM HYMAN presented a girl, sixteen years of age, who had since early childhood constant dribbling of urine day and night. There has never been a period when this has ceased. She voids normally four or five times during the day. Her general health has always been excellent. She has been examined on a number of occasions, and treated for a nervous form of enuresis. She was a well-developed, healthy girl. There is considerable excoriation of the labia and the inner aspect of the thighs, the result of constant dribbling of urine. A first inspection of the vaginal outlet was negative. A catheter was then passed into the bladder and some eight ounces of clear urine withdrawn. A pledget of cotton was then placed in the vaginal orifice; about ten minutes later this pledget was soaked. The bladder was then filled with an indigocarmin solution, and another pledget inserted and removed ten minutes later. It was found soaked with urine, but colorless, thus demonstrating that it was not a vesicovaginal fistula. By means of a strong light and a speculum, a tiny opening was revealed on the anterior vaginal wall, just behind the external meatus. Drops of urine were seen coming from this orifice. Attempts to probe the orifice with fine catheters or bougies were negative, an obstruction being encountered at about one centimetre distance. The condition was apparently an ectopic ureter opening into the vagina. A cystoscopic examination showed a normal bladder and ureteral orifices. Both ureters were catheterized to pelvis and clear urine was obtained, with good equal function as determined by indigocarmin. The urine from the third ureter contained no blue after thirty minutes, and was of a pale, watery consistency. The catheterized specimens from the two normally placed ureters contained 1.2 per cent. urea; that from the ectopic ureter showed 0.2 per cent. urea. A röntgenogram of the urinary tract was negative. A film taken with two opaque catheters *in situ* showed a normal position of both kidneys. The ureteral orifice in the vagina was then injected with iodide. After about thirty cubic centimetres had been introduced the patient complained of pain in the left loin. A röntgenogram then taken showed a considerably dilated ureter, ending in a small pelvis in the region of the left kidney. A pyelogram of the left pelvis showed a normal outline, and was in close proximity to the pelvis communicating with the third ureter.

*Operation.*—September, 1927. A left lumbar incision was made, exposing a normal-sized kidney with an accessory ureter coming off the upper pole of the kidney. This ureter was markedly dilated all the way down to the pelvis. The normal pelvis was situated in the middle of the kidney and was not dilated. A careful examination of the blood vessels was made and it was found that the vessels entered the kidney in their normal relation, with the exception of a large branch of the renal vein which entered the upper pole of the kidney behind the ureter.

*Procedure.*—It was decided to resect the upper pole of the kidney. The ureter was opened, and a finger introduced into the pelvis to demarcate its

outline. The upper pole of the kidney was then resected, after ligating the branch of the renal vein above-mentioned. The ureter was freed as far down in the pelvis as could be reached through a lumbar incision, cut across, and the stump carbolized. The upper pole of the kidney was closed with mattress sutures, using fat implants, and the wound closed in layer sutures, with rubber dam drain.

The dribbling stopped immediately after operation. The patient made an uneventful convalescence and was discharged from the hospital within three weeks after operation. A control cystoscopy on November 14 (about two months after operation) showed that indigocarmin appeared in equal concentration from both kidneys within a few minutes after intravenous injection, and that there were no evidences of retention of urine in the left kidney. There has been no incontinence at any time since the operation.

## BILATERAL DOUBLE PELVES AND DOUBLE URETERS

Dr. Abraham Hyman presented a man, twenty-eight years of age, who was admitted to the hospital in January, 1922. He had been complaining of pain in the back and frequent urination for two years. These symptoms had been increasing in severity of late, and the patient had noticed that his urine was turbid. Neither kidney was palpable or tender. The röntgenogram of the genito-urinary tract was negative. The urine was cloudy, containing large amounts of pus. The phenolsulphonephthalein test was 40 per cent., blood chemistry normal; the Wassermann negative. Cystoscopic examination showed an inflamed bladder. The right ureteral orifice was considerably retracted, and an impassable obstruction encountered at fifteen centimetres. No flow of urine or indigocarmin was obtained from this side. The left ureteral orifice, which was normal in appearance, was catheterized and clear urine obtained, with good indigocarmin within fifteen minutes. At the time the first cystoscopy was done, it was not noticed that there were two extra ureteral orifices. A diagnosis of right sided infected hydronephrosis was made.

At operation it was discovered that there was a double pelvis with two ureters. The kidney was found atrophic and hydronephrotic. In view of the fact that there was practically no kidney tissue left, a nephro-ureterectomy was done, removing the kidney and ureters in one piece down to within an inch of the bladder. This necessitated an anterior extra-peritoneal incision. After operation the patient's urine was perfectly clear for about a week, when it suddenly became turbid. In view of the findings on the right side, a similar condition was suspected on the left.

The patient did not return again until October, 1927. In the interval he had been fairly well except for attacks of pain in the left lumbar region with moderate frequency of urination. The urine had been increasing in turbidity and the patient finally consented to undergo a second cystoscopic examination. This showed an inflamed bladder. There were two ureteral orifices seen on the right side. These could only be catheterized a short distance. The ureteral orifice on the left side was considerably swollen. Above and to the outer side of the ureter there was an inflamed, œdematous area which appeared to be a second ureteral orifice. This orifice, however, could not be catheterized, and no indigocarmin was observed coming down. The normally placed left ureteral orifice was catheterized to the pelvis and clear urine obtained, with strong indigocarmin. The catheterized specimens showed occasional pus cells. At a third cystoscopy the same findings were observed, it being impossible to catheterize the second orifice. A diagnosis

was made of double kidney and double ureters, with infection of the lower pelvis and ureter.

*Operation.*—October 14, 1927. A left lumbar incision exposed a double kidney, the upper half represented by normal, solid looking parenchyma. The lower half was hydronephrotic. The kidney was somewhat contracted in the middle at the point of fusion of the upper and lower halves. The ureter coming from the upper half of the kidney was normal in size and appearance; that from the hydronephrotic part of the kidney was considerably dilated. Fortunately, the main blood supply entered the upper half of the kidney. A heminephrectomy was done, with removal of the dilated ureter as far down as could be reached through the lumbar incision. The bleeding was controlled by means of mattress sutures.

The day following operation the patient passed only a few ounces of urine, and for the succeeding twenty-four hours the output was about four ounces. The patient then became stuporous, although he could be aroused. The blood chemistry, which prior to operation showed an urea of twenty-three, now rose to thirty-two. The urinary output steadily increased, under diuretics. This peculiar stupor lasted for about three days and then entirely cleared up, the condition evidently being a post-operative psychosis. Despite the fact that his urinary output increased steadily, his blood chemistry mounted, the urea reaching as high as seventy-three milligrams a few weeks after operation. A considerable collection of pus was found in the wound. After thorough drainage his general condition gradually improved and the urea dropped down to forty-nine milligrams.

His condition now is very good. The urine is perfectly clear, and a blood chemistry taken a few weeks ago was normal.

## POLYPOID GASTRITIS—PARTIAL GASTRECTOMY

Dr. Edward Rutherford Cunniffe presented a woman, thirty-one years of age. Fifteen years ago she was operated upon for redundant colon for which a colopexy was performed. The appendix was removed at that time. She had a tonsillectomy done five years ago. She had enjoyed good health since that time.

In July, 1928, she contracted a sore throat and was confined to bed for one day. The glands on both sides of her neck were painful, tender and swollen. She improved slightly during the next few days and returned to her home four days after illness began, despite continued prostration and fever. Three days later she began to vomit. She was unable to retain anything she ate or drank. Vomitus was sometime bile-stained, but at no time was there any evidence of blood. There was no pain at this time except that associated with vomiting. She remained at home for three weeks. Her condition did not improve and pain and tenderness appeared in upper abdomen. The reporter saw her first August 11, 1928. Her temperature was 101° F., pulse 110, respiration 24. Tenderness was indefinite over her entire upper abdomen. She was admitted to the Union Hospital on that day, where she remained for two weeks; during that time temperature remained at 102° F., for first four days of her stay, pulse dropped from 100 to 80 and respiration about 20. White blood cells were 18,000, 72 per cent. polymorphonuclear leucocytes. After four days her temperature gradually became normal. Chief complaints at that time were persistent vomiting, distention and generalized abdominal pain, which at times localized in the right upper quadrant and epigastrium. X-ray examination revealed an apparently normal gall-bladder—duodenum and pylorus negative. Her progress was slow and vomiting was difficult to control

during the first week of her stay. She then improved somewhat, and was discharged, August 14, 1928, still vomiting and very nervous.

She was not seen again until October 9, 1928, when she returned complaining of an aggravation of all her symptoms of abdominal pain, tenderness and persistent vomiting. She had been unable to retain even fluids during the past ten days. Another gastro-intestinal series taken during this time showed a constant large defect in the pars pylorica. She was again admitted to the hospital, and on October 9, 1928, under gas, oxygen and ether anæsthesia, the abdomen was opened by incision to the right of the median line. Many adhesions were encountered, due no doubt to the previous operation of colopexy. When the stomach was brought up into view, the pylorus was about twice the normal size and felt quite soft and thick, and was of a peculiar consistency which was typical of neither a carcinoma nor an ulcer, but resembled somewhat a leather-bottle stomach. This condition extended approximately fifteen centimetres along the stomach and was more marked over the greater curvature, but could be felt at the lesser curvature near the pylorus. A partial gastrectomy was then done.

During the first post-operative day the patient vomited three times small amounts of dark red fluid, which was of no particular consequence. During second post-operative day she vomited one ounce of light colored fluid and did not vomit again. During first three days after operation she was supplied with fluids, intravenously, subcutaneously and by Murphy drip. Glucose was given with insulin. From that time her recovery was smooth and uneventful. The Murphy button passed by rectum on the nineteenth post-operative day. Has had but one attack of vomiting since operation, this occurring four days ago when she thought she was guilty of over-eating.

*Specimen.*—Upon examining the excised portion of the stomach a very thickened and polypoid condition of the mucous membrane was found both in the upper part of the section and at the pylorus. A distinct polypous outgrowth was found in the upper part of the specimen and another large one at the pyloric ring.

Beginning just proximal to the pylorus and for a distance of seven centimetres the mucous membrane was entirely missing and appeared as if a cast of the mucous membrane had been removed, denuding the entire circumference of the stomach.

*Pathological Report.*—Specimen consists of a resected portion of stomach pylorus and four centimetres of duodenum. The mucosa is raised and thickened. For a distance of four centimetres over pyloric valve, the mucosa is completely denuded down to muscularis, which is covered with a diphtheritic membrane. There is an ulcerated sac one centimetre deep beneath the mucosa on the lesser curvature.

*Microscopical.*—In all of fourteen sections taken from various portions of the specimen the condition was found to be polypoid gastritis with no signs of malignant features.

A later report from Doctor Ewing, received November 26, 1928, is as follows: "I would prefer the diagnosis of chronic gastritis with atrophy of mucosa, and a very marked lymphoid infiltration and hyperplasia with ulceration. Only one polyp seen that is not connected with the ulcer. True polypoid gastritis shows adenomatoid polyps. In this case the elevations are due to lymphoid hyperplasia."

## RECURRING INTUSSUSCEPTION

DR. EDWARD R. CUNNIFFE presented a boy, first observed during July, 1927. He was then six years of age and complained that for the previous six months he had suffered with recurring attacks of general abdominal pain and vomiting. The pain would occur very suddenly and was always followed

by vomiting (with slight periods of remission of pain). This condition would last for about twenty-four hours; they would occur about twice every two weeks, with frequent vomiting. There was never any elevation of temperature and no blood was found in the stools. An exploratory laparotomy was advised, to which the parents did not consent at that time. They returned on September 8 with a history of four similar attacks since last examination, two months before.

The boy was operated upon at Union Hospital September 10, 1927. When the abdomen was opened a small, easily reducible intussusception was found in the ileum. This reduction was accomplished by simply picking up the ileum when the intussusception reduced itself. The appendix was removed. On further examination large mesenteric glands were found in the region of the lower ileum. The abdomen was closed without drainage and convalescence was uneventful. The patient was discharged from the hospital on the fourteenth post-operative day. The boy was not seen again until February 26, 1928, when he returned with the history that he had had attacks of abdominal pain and vomiting similar to those previous to his operation. The first one came on one month after leaving hospital and since that time had recurred every two or three weeks and lasted for about twenty-four hours. He had an attack two days before which, during the first twenty-four hours, was similar to his previous attacks, but his condition steadily grew worse during the second twenty-four hours, with frequent vomiting and abdominal pain. The patient was acutely ill, and had a pinched facies, and complained of severe generalized abdominal pain. His temperature was 102° F., pulse 130, respirations 26 at this time. Abdominal examination revealed some resistance, but no definite rigidity. A large, tender mass could be felt in the right lower quadrant. On rectal examination no mass could be palpated, but some blood was noticed on examining finger. The patient was immediately sent to the hospital and the abdomen was again opened at the site of the old scar. The mass was easily brought up into the wound and found to be an irreducible intussusception of ileum into ileum, about ten inches from cæcum.

The involved portion was very dark in color, and a slight attempt at reduction caused a rupture of the wall. No further manipulation was done. On account of the desperate condition of the patient, the mesenteric vessels were ligated and the intussusception was excised. The free ends were brought through the abdominal wound and sutured as in a Mikulicz operation, except that a tube was sutured into each lumen, as recommended by Paul. No Paul's tubes being available, plain rubber tubing was used. Patient drained freely of intestinal contents, but condition was very poor during first twelve hours with vomiting of black foul-smelling fluid. Infusion saline 600 cubic centimetres given, Murphy drip by rectum. Patient's condition continued poor. That night patient was restless, but draining freely, and no vomiting; temperature was 106° F., pulse 140, respiration 30.

The drainage of intestinal canal through tubes was profuse, but it was apparently a very important factor for after the first twelve hours the condition improved very rapidly. However, the tube slipped out of one end of intestine and although replaced it could not be held in intestine. There was also some necrosis of the protruding portion of the bowel, and the skin about the wound became very much excoriated by the discharge.

Various means were tried to improve the condition of the skin so that a suture anastomosis might be done, but it was difficult and little improvement was noticed. April 10, an attempt was made to crush the spur, as in a typical Mikulicz operation. A heavy clamp was placed on the spur and

tightened as much as possible; leaving it on until the clamp was found free. Although this was tried with various clamps at different intervals they were unable to break down the spur. A special clamp was devised with which they were now successful and the patient began to pass some fæces by rectum. However, the fistulous opening was so large that there was still considerable drainage from this opening. After waiting until June 14 to secure a better external condition for closing the intestinal gap and finding little improvement, the small intestine was mobilized (under ether anæsthesia) and the opening closed as is sometimes necessary in a Mikulicz operation on the large intestine. This was very successful, no leakage occurred. Patient had a normal stool forty-eight hours later and thereafter his convalescence was uneventful.

DOCTOR CUNNIFFE remarked that this boy illustrated the recurring type of ileal intussusception without satisfactory etiology, no tumor being found in this specimen. No other pathology was found in the abdomen except several enlarged mesenteric glands. He called attention to the method of treatment for providing drainage of the intestinal tract.

## THROMBOSIS, INFARCTION AND EMBOLISM

DR. CHARLES F. FARR read a paper with the above title, being a clinical and statistical study from the First Surgical Division (Cornell) of the New York Hospital, for which see page 481.

DR. LEWIS A. CONNER remarked that the old and long controversy as to whether thrombosis was the primary condition or whether a change in the surface of the intima—in other words phlebitis—was the primary process in thrombosis is still unsettled. Doubtless the condition is not always the same. The last ten or fifteen years have brought to light a great many interesting facts and there are many resemblances between thrombosis formation in the veins, and the formation of sand bars in flowing streams. The resemblances are very close in some respects, but the sand-bar analogy cannot be applied too strictly. Nevertheless thromboses do form, as do sand bars, where there are eddies in the stream at the junction of veins, or where there is slowing of the current due to widening just above the vein valves. These are the places where thrombosis usually begins. In considering the etiology of these post-operative cases one has to bear in mind these facts. Doctor Conner was inclined to think that improvement of the venous return is a much more important consideration than any low-grade infection or extension from the wound. It is very difficult to understand why, for example, in a perfectly clean operation on chronic appendicitis thrombosis can develop in the left femoral or popliteal region. One of the points worth emphasis is that a venous thrombosis forms very gradually. There is a deposit of blood platelets at the point where the thrombosis begins and this often seems to be a very gradual process, a matter of perhaps a week or two before the vein is completely occluded by the thrombus. That period, when the thrombus is forming and when the vein is not yet occluded by the thrombus and the blood is still flowing in it, is the time when minor emboli are very apt to occur, even before there is any local clinical signs of

thrombosis. One should make a sharp distinction between these small emboli, which are apt to be released early in the process of thrombosis, and the massive, fatal emboli which result from dislocation of a large, fully formed thrombus. These latter seem to be much more frequently seen in post-operative states than in medical conditions.

The symptoms resulting from the small emboli are often mild and may easily be overlooked, especially if local signs of thrombosis have not yet appeared. A sharp attack of pleural pain, with or without a cough, and some blood-streaked sputum may be the only symptoms. While it is not always easy to distinguish between these milder attacks of pulmonary embolism and post-operative inflammatory conditions in the lung, the differential diagnosis can usually be made. The attacks of embolism are apt to occur later in convalescence (usually in the second week), to begin with sharp, pleural pain and to have no cough or fever until a day or two later. Post-operative pneumonia, on the other hand, usually gives symptoms during the first two or three days after operation and fever and cough usually precede the pleural pain, if indeed any pain be present. Moreover, when blood shows in the sputum in cases of embolism it is frank, unchanged blood, either bright or dark, and has not the characteristic, diffuse rust color of pneumonic sputum.

In the attempt to prevent the development of thrombosis after operations a great variety of measures had been suggested and employed. Acting upon the theory that the chief predisposing cause was the slowing of the blood stream in the large veins, the Germans had for some years urged that patients after abdominal operations be gotten out of bed at the earliest possible moment. It was the speaker's impression that statistics had thus far failed to show any important lessening of the incidence of fatal pulmonary embolism as a result of this practice. Lockhart-Mummery had urged the avoidance of preliminary purgation and of a starvation diet before and after operation, the furnishing of suitable mattresses for the operating table, the avoidance during operations of such strained positions as may cause pressure on the veins of the extremities, and the encouragement of free movement of the limbs after operation. It seemed reasonable to suppose that tight abdominal bandages, which restrict greatly the free movement of the diaphragm and so interfere with one of the important factors in assisting venous return from the lower part of the body, might predispose to thrombus formation and should therefore be avoided as far as possible.

Dr. Seward Erdman understood Doctor Farr to say that in none of the fatal cases of embolism had there been any symptoms recognized even in retrospect which suggested development of a thrombus.

Many surgeons will agree with Doctor Farr as they call to mind some tragic experience with a fatal pulmonary embolus, occurring on the tenth or eleventh day after a simple, clean herniotomy, and an apparently smooth convalescence.

The speaker had gone in detail over the charts of several such cases and

did find in each instance some slight, but perhaps very significant persistence of temperature into the third, fourth or fifth post-operative day.

If such charts were compared with the average perfectly normal post-operative temperature curves the discrepancy would be apparent.

Furthermore, in review of the charts, in several instances there was mention in the nurse's bedside note that "patient complained of pain in the leg", which must have been so slight that no attention was paid to it.

As to length of time which intervened between the onset of the acute signs of pulmonary embolism and the actual death of the patient, this in most cases was probably not more than fifteen to thirty minutes, or even less. Occasionally such cases linger on much longer, even up to four or six hours and it is interesting to speculate on the possible explanation.

About five years ago, on the Second Surgical Division of the New York Hospital, a woman died of pulmonary embolism in the course of a smooth post-operative convalescence. About half an hour after the onset of the desperate embolus symptoms she complained suddenly of pain, numbness and tingling in both legs and lost control of them. She lingered on for about two hours after the onset. At autopsy the usual findings of a large clot blocking the pulmonary arteries was found, but there was also the very unusual finding of an eight-inch-long snake-like clot in the abdominal aorta blocking the bifurcation into the common iliacs.

This clot was of similar appearance to that found in the pulmonary artery and suggested a similar point of origin.

The heart was now carefully examined and the foramen ovale was found to have a rather wide slit-like opening from right to left auricle, large enough, it was felt, to have allowed the clot arriving in the right auricle to pass into the left auricle and thence to the aorta.

The anatomists, Quain and Gray, state that "not infrequently" a small, slit-like opening persists throughout life, at the upper edge of the foramen ovale; perhaps 20 to 30 per cent.

Doctor Erdman believed that when an embolus blocks the pulmonary artery, the pressure on the right side of the heart must rise above that on the left, and in this manner would tend to force venous blood from the right auricle over into the left auricle, if any opening existed through the auricular septum.

This, of course, would be a reversion toward the foetal heart circulation.

This theory would be the plausible explanation of the clot found in the abdominal aorta at autopsy; but, furthermore, may explain the prolonged period of symptoms in certain cases of fatal pulmonary embolism.

Dr. Richard Lewisohn pointed out that in about five cases recorded in the German and Scandinavian literature, the pulmonary embolus was removed and the patients were cured. It is difficult to say whether any of these cases might have recovered automatically.

Dr. John Douglas said that apparently Doctor Farr has found very

little which would appear in the way of etiological factors beyond infections. The discussion of the last speaker and also that of Doctor Erdman made him want to ask Doctor Farr if in these fatal cases there was a sufficient length of time that any of them lived, which would have made possible operative interference. There must have been a very small number where the patient lived long enough to do an operation of that kind and at the same time not give the impression that they would get well anyway. One hesitates to risk life by removing clots from the pulmonary vein if there seems a prospect of spontaneous recovery. Another question in these cases of pulmonary infarction from small emboli, which are apparently occurring where one could possibly reach them by operation, has Doctor Farr any evidence or presumptive evidence that it would be of any use to try to remove the foci from which the emboli arise in these cases? Doctor Douglas did not mean where it comes from appendicitis. He had one post-appendix case last summer that had pulmonary embolism occurring about the eighth or ninth day. He had another patient, a woman, who, while under observation previous to operation, developed a pain in the chest and the next day complained of pain in the leg and gradually developed more or less migrating superficial phlebitis in the internal saphenous vein. Is there anything to be gained in these cases by tying the saphenous vein?

Doctor Farr, closing the discussion, stated he had seen cases in which a clot in the right heart had progressed into the pulmonary artery and apparently had been the cause of death, and in which there had been no other thrombosis.

On studying the charts of these fatal cases one frequently, perhaps always, would find some evidence that things were not progressing normally. On the other hand, in his series there had not been one case, so far as he knew, in which the actual condition of thrombosis had been determined before death. During the last three weeks he had had three post-operative cases of phlebitis of a decidedly definite type—the usual superficial phlebitis following various abdominal operations. These as usual had ended in recovery and he had learned to expect good results in all such obvious cases of phlebitis.

As to getting ahead of the process of phlebitis by excising the vein he had once done this in a case from the Medical Division. The patient suffered from enteric fever with severe infection of the internal saphenous vein. Many abscesses had formed along the course of the vein. The vein was ligated proximal to any palpable thickening and the abscesses were opened separately. The patient recovered. Certainly in the great majority of obvious cases excision or ligation is uncalled for while the very nature of a deep and hidden phlebitis would preclude diagnosis and operative treatment.

# TRANSACTIONS

# PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 8, 1929

The President, DR. ASTLEY P. C. ASHHURST, in the Chair
CALVIN M. SMITH, JR., M.D., Recorder

## STAB WOUND OF THE LEFT VENTRICLE

DR. WILLIAM BATES presented a man, twenty-eight years of age, who was admitted to the Accident Ward of the Graduate Hospital November 15, 1928. He had an incised wound in the anterior aspect of the left chest. The wound in the chest wall was about one and a half inches long, was vertical and just to the outer side of the left border of the sternum. The patient's temperature was normal; his pulse forty-eight. The heart sounds showed a curious scraping or catching in the rhythm. The pulse rate quickly mounted and the area of dulness in the precordial region rapidly increased. The wound was explored by enlarging the vertical incision upward and downward. It was found that the knife had passed through the costochondral junction of the third and fourth left ribs. This detachment was utilized for further exploration and the intercostal muscles between the second and third and between the fourth and fifth ribs were severed and the ribs broken about two inches from their traumatic detachment. This was made possible by a skin incision at right angles to the middle of the original incision.

This osteoplastic flap was laid back and an opening in the pericardium exposed to sight. Bleeding was rather steady and came from within the pericardium rather than from a cut vessel in the edges of the pericardium. The pericardial opening was enlarged upward and downward. At first nothing could be seen because of the bleeding, but gradually by sucking and sponging it was seen that the left ventricle had a wound in the right upper portion. It was impossible to determine whether or not its opening communicated with the left ventricular chamber, but from the amount of bleeding the reporter believed that it did not. The muscular bleeding was very steady and with each contracture and rotation of the heart there was a steady spray of blood carried in the form of an arc on the table drapings above the wound. The wound in the ventricle was closed with the chromic catgut. The pericardium was then washed out with normal saline and the pericardium was being closed when the heart stopped. A little finger irritation through the wound and ten minims of one to one thousand adrenalin chloride intravenously was given. Intravenous normal salt solution was then started. The pericardium was about closed when the heart again stopped, but gentle massage and additional adrenalin in the intravenous solution reëstablished contractions and no further cardiac arrest occurred. The osteoplastic flap was brought into place after the pericardium was completely closed. A small wick drain was put down through the intercostal space on top of the pericardium and the skin was closed with interrupted silk sutures.

During the operation the pulse rate went to 108. The patient was in the hospital twenty-seven days. His leucocytes immediately following opera-

tion were 10,200 per cubic millimetre, and just prior to discharge were 10,400. The Wassermann was strongly positive; the blood chemistry during his stay in the hospital was normal. The cardiac dulness was greatly increased to the left, and X-ray of the heart showed a very decided increase of the cardiothoracic ratio. Both by electrocardiogram and X-ray this widening steadily decreased until the last X-ray showed a practically normal relationship. Five days after the operation the electrocardiogram showed a true picture of acute coronary occlusion. One week later, or twelve days after operation, with a pulse rate of 90, the electrocardiogram showed no evidence of coronary occlusion and Dr. James M. Talley stated that chronic coronary occlusion might develop later. Two weeks later, or twenty days after operation, with a pulse rate of 75, the electrocardiographic tracing again suggested coronary occlusion. A fourth reading, taken just prior to discharge on December 12, showed no coronary occlusion. During that part of his stay in the hospital when the temperature was elevated and the patient had a high leucocytosis, it seemed as if it were going to be necessary to drain the pericardium for fear of pyogenic invasion of the hæmopericardium. This, however, was not necessary and the patient now is able to do some work while continuing to receive rather strenuous antiluetic treatment.

## MORTALITY OF INTESTINAL OBSTRUCTION

DR. SELLING BRILL (by invitation) read a paper with the above title for which see page 541.

DR. JOHN B. DEAVER said, regarding strangulated hernia, that in his experience most cases of strangulated hernia have had too much taxis before being referred for operation as demonstrated by blood in the sac and in the mesentery, the latter particularly favoring gangrene. When it was his privilege to teach undergraduates he always told them not to do taxis, but to operate immediately.

In operating for strangulated hernia, a mistake that often occurs is when having opened the sac and before releasing the strangulation not to cleanse it, as well as to have smears and cultures taken of the fluid contents. Where this precaution is not taken and the fluid contents are infected, release of the strangulation makes communication with the peritoneal cavity, and through this communication the infected fluid can find its way into the abdomen and result in infection of the peritoneum. Intestinal obstruction following operation for appendicitis can usually be avoided. In the speaker's experience the majority ·of these obstructions occur in the lower abdominal abscess cases. Quite a percentage are the result of the involvement of the terminal coil of the ileum when it forms a part of the wall of the abscess. Where he finds the terminal ileum involved to the extent that it has lost its flexibility, he makes an ileocecostomy or an ileocolostomy. This prevents both immediate and remote obstruction. As this is his practice, he rarely sees an obstruction any more. Bear in mind that this ileocecostomy or ileocolostomy, as the case may be, is not done with the object of arresting peritonitis, if present.

DR. GEORGE P. MULLER said that we were apt to be carried off our feet by the many beautiful pieces of work being done; that of Hayden and Orr

being the last of a long series, in which the whole thing is made to appear as a form of toxæmia which can be combated by replacing the electrolytes. In experimental lower intestinal obstruction—the kind we usually see—there was no disturbance in the electrolytes, so one cannot expect to do a great deal of good by pumping salt solution into the patient. Doctor Brill found that mortality was directly traceable to delay in operation, in all types of cases except a few congenital herniæ. etc. In the herniæ there was no mortality in the first twelve hours, but after that it was 50 per cent. Regarding paralytic ileus, this occurs mostly in patients with general peritonitis, i.e., when the abdomen was opened it was found swimming with pus. These patients made a desperate fight for a few days and then increasing distention occurred. As to enterostomy Doctor Muller believes that it rarely accomplishes anything except drainage of the loop selected. It is only when peristalsis is very active—and it rarely is—that the upper intestine can be emptied. With Doctor Deaver, the speaker does not believe in jejunostomy; it does no good except in the rare cases where one can demonstrate peristalsis and reverse it. In obstruction following appendiceal operations, when we close with some angulation of the lower coils, it means trouble in a week or ten days. This is traceable to the effects of operation. However, in patients where the appendix had been stripped out of a gangrenous area which reached down into the mesentery of the ileum and obstruction occurs later it is hardly any fault of the operator. In order to avoid obstruction the speaker adopted the McBurney incision, as in this way one gets drainage outside of the coils of the ileum, and no drainage across the coils. It definitely lowers the percentage of obstruction following operation. The speaker thinks the Deaver operation of ileocolostomy is entirely too severe for the average patient. He would not feel justified in making a mid-line incision to do an ileocolostomy in the presence of acute peritonitis.

Dr. Damon B. Pfeiffer said that he has seen a few cases where he is sure that the performance of jejunostomy saved life. In the last few months the speaker had such a case in the Presbyterian Hospital, in which instance jejunostomy certainly saved life. There was infection of the lower abdomen following resection of carcinoma of the cæcum. The infection was limited to the right lower quadrant. The patient became greatly distended and for six days never passed gas; his condition was such that he was practically in collapse and looked ready to die at any moment. In these circumstances jejunostomy was made and he drained off two or three gallons of fluid by the next day. No gas was passed by bowel until three days later. This patient gradually recovered. Doctor Pfeiffer has had two or three other similar cases and believes that there is a small definite field for jejunostomy in which it is definitely a life-saving procedure. He did not wish to stress the indications for its use, but simply to ask for an open mind on the subject.

Dr. Charles F. Nassau said that one need not be afraid to give morphin, particularly in the presence of peritonitis. The bowels should

be put in splints after operation. An endeavor to make the patient's bowels move is dangerous; it is wiser to almost forget that they need to move. In abscess cases, having achieved localization by the Ochsner treatment, why spoil the effect by creating peristalsis which is dangerous and sometimes fatal in the presence of adhesions? He has had two patients who were doing well when the over-anxious attending physicians ordered castor oil because the bowels had not moved for two or three days and who immediately developed obstructions. Until the patient is practically healed up one should depend on the use of enemas for bowel movements.

Sometimes the surgeon treats a strangulated hernia, particularly of the femoral type, where lack of experience will cause him to do an intestinal resection. In this way a certain number of patients are lost, even if the operation be done under local anæsthesia. A little hope and faith in the ability of a bad looking piece of bowel to recover itself when put back where it belongs, the abdomen drained by a tube of gauze and rubber dam to the bottom of the pelvis and enough gauze in the opening to keep the bowel back, will bring much better results. In a number of cases the speaker has put back bowel that years earlier he would unhesitatingly have resected. In other words, one can afford to take the chance of having the formation of a fistula. He is in accord with Doctor Brill in his remarks about fancy operations after the original work. If the original work be well done, let the patients alone and they have a better chance for recovery. Emptying one loop of bowel fifteen feet from where the damage is will not do the patient a particle of good.

## PERFORATED PEPTIC ULCER

Dr. John B. Deaver read a paper with the above title for which see page 529.

Dr. Charles F. Nassau said that if, instead of division of the pyloric sphincter, which is perfect as far as it goes, the surgeon would do a Finney operation, he would accomplish the same thing; it is a perfectly safe procedure; it cures; and the patients almost never have recurrence of their ulcers. Doctor Nassau does not use clamps, having lost one patient whom he believes died of a necrosis following the use of a clamp.

Dr. George P. Muller said that years ago he read a paper by Judd suggesting the performance of the Ramstead operation. He has done it five or six times since then and has had one case of marked pyloric stenosis without evidence of ulcer in which that operation was done in either 1920 or 1921. The woman is well and was relieved of her symptoms. This is a minor procedure as compared to that which Doctor Deaver performs. The speaker did not quite see how Doctor Nassau reasons that the Finney operation will give no mortality when compared with gastro-enterostomy. It is easier to do a gastro-enterostomy than to do a Finney operation, and that should in a way make for complications. The Finney is a difficult operation to do even with practice; there is always a tendency for the lower

edge of the duodenum to tear away. Apparently no operation on the stomach is one hundred per cent. successful and one has to decide in the individual case. He has been doing the Judd operation, taking out an oval section and thus getting a wide-open pyloric end; it is infinitely easier to do. Some years ago, while in Rochester, the speaker saw Judd do twelve of these operations in a few days, and was exceedingly impressed with certain facts, namely, that he had not been making large enough incisions and not making the oval sufficiently big. So far no one operation has proven always successful.

Dr. John B. Deaver said that he could concur in a great deal, but not with all that has been said. He thinks that Finney can accomplish more with his operation than anyone else can. The speaker has done it and had good results, but with Doctor Muller he thinks it more of an operation than is posterior gastroenterostomy. Marginal ulcer will occur after a Finney operation. He agrees with Doctor Muller that there is not any one procedure which is absolutely perfect.

# BRIEF COMMUNICATIONS

## A METHOD FOR THE PERFORMANCE OF ENTEROSTOMY IN CASES OF STRANGULATED INGUINAL HERNIA WITH GANGRENE OF THE BOWEL

My OBSERVATION is that it is the strangulated form of hernia that is usually most poorly handled. There are certain handicaps and serious obstacles to be overcome here. The operator usually has no means of knowing the proximal from the distal end of the bowel. It would be hazardous and unwise and a waste of time for him to prolong the operation sufficiently to find out, when he does not know, for instance, by the nearby location of the cæcum, or some such landmark. Enterostomy drainage can take care of both ends if used in accordance with the method described. If the bowel is damaged, but partially viable, necrotic spots should be reënforced by suture. Inasmuch as the damaged segment of bowel is likely to be the seat of a mechanical obstruction, a suitable enterostomy should be done. The intrabowel portion of the tube is carried all the way through the damaged loop, the tube having previously been split spirally and several lateral openings made in its sides with scissors. The tube so arranged will drain from healthy bowel at both ends of the damaged segment.



Fig. 1.—Enterostomy in Strangulated Inguinal Hernia, with Gangrene of the Bowel.

Believing that the enterostomy opening should be protected and made as valve-like as possible, I have not only made use of the Horsley method of securing it in the bowel, but have, when available, tucked omentum about it by suture, or passed it through a perforation in the omentum. In case the omentum is absent, however, I have found that the appendices epiploicæ of the sigmoid made a most satisfactory substitute.

As to reaction of necrotic bowel, an end-to-end anastomosis by the invagination method is by far the speediest type of anastomosis; also one of the safest as regards the possibility of leakage, always safeguarding the anastomosis by an enterostomy.

My observation has been that a considerable number of lives have been lost by dilly-dallying with makeshift methods in dealing with bowel necrosis,

when discovered in the hernial sac. To secure results the surgeon should act with decision, accuracy and despatch. Such methods as leaving both ends of the necrotic bowel in the hernial wound with a drain in each with the hope or the idea of anastomosis at a later date may be of possible value in certain cases, but I believe that, generally speaking, a definite resection with anastomosis as previously described will give by far the lower mortality.

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# FIBROSARCOMA DEVELOPING IN A DESMOID*

STEWART and Mouat and others [3, 6, 7] have studied desmoid tumors. The former reviewed sixty-six cases of fibromas (desmoid tumors) of the abdominal wall. They found that these neoplasms occur most frequently in women who have borne children and that they commonly arise from the musculo-aponeurotic structures of the anterior abdominal wall below the umbilicus. Morison and Drummond observed that these new growths in the abdominal wall are rarely tender on palpation. With the patient prone, raising the head or shoulders does not cause the tumor to disappear but sometimes makes it more apparent. Early in their growth the tumors enlarge parallel to the muscle-fibres; later they may encroach laterally. Balfour reported seven cases of desmoid tumors of the abdominal wall, two of these developing in close relationship to an abdominal incision. Nichols found in thirty-one cases of desmoid tumor that twenty-five of the tumors occurred in the abdominal wall and nineteen apparently arose from the aponeurosis of the rectus muscle.



FIG. 1 —Section from margin of tumor illustrating fibrous connective-tissue components. In lower half are a few muscle bundles engulfed by new growth (x 75)

There is frequently a recurrence of the tumor after incomplete removal. Morison and Drummond reported a case in which there was a history of four operations, three of them for recurrence. Several observers [1, 4, 8, 9, 11] have mentioned the possibility of malignant change. Stewart and Mouat, on the other hand, in their series did not find evidence of sarcomatous metamorphosis.

The structure of a desmoid tumor, according to Ewing, "usually varies from that of a hard acellular fibroma to a rather cellular fibrosarcoma, the latter exhibiting active growth and not infrequently recurring after incomplete removal. The prognosis is good and there seems to be no record of the development of definite malignant qualities or metastasis. The majority of these tumors respond slowly but satisfactorily to radiation."

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RLPORT OF CASE —An unmarried woman, a bookkeeper, aged twenty-two, came to the clinic because of a painless, symptomless tumor of the anterior abdominal wall below the umbilicus. She had discovered the lesion accidentally. The tumor had increased slightly in size in the two months between its discovery and examination at the clinic.

Examination revealed a hard fixed tumor apparently involving the lower part of the left rectus abdominis muscle. A clinical diagnosis of desmoid tumor of the abdominal wall was made. At operation, a hard gray to white fibrous tumor was removed. The new growth apparently began near the space of Retzius and extended upward in the substance of the left rectus abdominis muscle for about 9 cm. Grossly the tumor was composed of interlacing whorls of gray to white fibrous tissue and scattered between these were light brown to tan softer areas. Microscopic examination of tissue from the fibrous areas of the tumor demonstrated the usual fibrous connective tissue-cells in the irregular arrangement so common in desmoid tumors. In certain areas of the tumor the muscle-fibres were engulfed by the new growth. Sections of tissue from the light brown to tan areas were much more cellular. The cells were distinctly fibroblastic in character and



FIG. 2 —Mitotic figures from a more actively growing portion of the tumor. A (×800) and B (×350).

there were numerous mitotic figures (Figs. 1 and 2). A pathologic diagnosis was made of a fibrosarcoma in a desmoid tumor.

Eighteen hundred milligram hours of radium treatment was given over the abdominal wound. Five months after operation the patient was apparently in good health.

Several points of especial interest are associated with the case reported. The patient had not borne children and laparotomy had not been performed, which is contrary to the common rule in these cases. The presence of sarcoma in the desmoid tumor is very unusual. At the time of the operation malignant change was suspected in the new growth and the suspicion was borne out by our subsequent microscopic examination.

Mitotic figures in neoplasm are strong evidence of malignant change. Most of us, if asked to give the microscopic signs of malignancy, mention the presence of mitotic figures in cells among the first of the changes. In the diagnosis of tumors arising from connective tissue the significance of irregular mitosis is undeniable. MacCarty, however, believes that mitotic figures are not necessary for the diagnosis of malignancy in cases of carcinoma, and Broders believes that they are not necessary in the diagnosis of epithelioma. In certain tissues, as for example, the germinal centres of lymph nodes, tonsils, or the epithelium of the cervix, mitotic figures are not infrequently found; of themselves, they are not indicative of malignant change.

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# HÆMANGIOMA OF CHEST WALL WITH UNUSUAL SYMPTOMS *

THE patient, a woman aged twenty, was admitted to the Surgical Service of St. Luke's Hospital, New York, October 25, 1927, with the following history:

Three years ago without known cause a soft painless swelling suddenly appeared in the second right intercostal space close to the sternum. At first this swelling was only noticed when she bent forward or on standing erect; on lying down it disappeared completely. During the last year and a half the swelling has been growing larger and does not now completely disappear on lying down. In addition a small hard nodule has appeared in the swelling. The nodule is tender and at times cannot be found, at other times when caught it will suddenly slip from between the fingers and disappear. The patient noticed that when the nodule is absent the swelling is larger.

Examination revealed in the second right intercostal space two fingers' breadth from the edge of the sternum a soft lense-shaped swelling three by two and one-half inches with indefinitely defined borders. It is attached to the deeper parts, the skin is freely movable over it and there are no signs of discoloration or surface heat. Pressure does not influence the size of the mass but posture does. In the erect or prone position the swelling is diminished, on bending forward the tumor quickly resumes its usual size. When the mass is shrunken a hard round body about one-eighth inch in diameter can be felt; the nodule is suggestive of a bony or cartilaginous fragment. At times it slips from the fingers and seems to disappear between the ribs. Coughing slightly enlarges the swelling, it does not pulsate, no thrill is felt and no murmurs are heard. The mass gives the impression of being a cold, or a latent bone abscess which connects with the thoracic cavity. The X-ray studies show an indefinite shadow three by four inches apparently in or just behind the anterior thoracic wall. The nature of the shadow was cleared up at operation. Plates taken after the operation failed to reveal it.

The patient was shown before the Surgical Conference and various diagnoses were made. The majority favored a cold abscess communicating with the thoracic cavity, a lipoma or a dermoid cyst communicating with the chest cavity.

At the operation a shirt-stud hæmangioma was found, the superficial lense-shaped expansion lay just beneath the pectoral fascia, the deep expansion lay between the pec-

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* Read before the American Surgical Association, May 2, 1928.

toralis major and the intercostal muscles. The stem of the collar-button connecting the deep and superficial portions was composed of a dilated varix which contained a hard ivory-like phlebolith. The deep portion of the hæmangioma communicated by several branches with the vessels of the thoracic cavity. The phlebolith which was situated in the stem of the collar-button moved forward and backward like a ball-valve. When the patient sat erect it slipped backward and blocked the main communicating vessels; the same check-valve effect was produced when the patient lay on her back. On bending forward the phlebolith slipped into a side expansion and allowed a reflux of blood from the posterior to the anterior expansion. The operation was performed under local anæsthesia and the mechanism of the filling and the action of the phlebolith could be readily observed. The hæmangioma was excised "en mass" and its communicating branches to the thoracic cavity ligated. There have been no signs of recurrence and the patient has worked steadily since the operation.           HENRY H. M. LYLE, M.D., *New York, N. Y.*

## MULTIPLE PERFORATED GASTRIC ULCERS

MASSON and Simon have recently reviewed the literature of multiple perforated gastric ulcers. They were able to find records of only thirty-two authentic cases, covering a period from 1876 to the present date. In view of the rarity of multiple perforated gastric ulcers, we wish to contribute the following case:

### CASE REPORT

Male, aged fifty-nine years, first seen in 1922 with symptoms indicating presence of an ulcer of the stomach; relieved by medical treatment. Five years later, October, 1927, again seen suffering from recurrence of stomach symptoms; he was still a fairly well-nourished man; increased acidity of gastric contents; occult blood in fæces; fluoroscopic examination of stomach revealed usual findings of an outlet ulcer with marked retention of barium at end of eight hours. At operation, October 29, 1927, there was revealed an ulcer in the first portion of the duodenum surrounded by large amount of scar tissue. Multiple adhesions between the pylorus, liver, and gall-bladder. The pylorus is almost occluded. Careful examination of the entire stomach did not reveal any other pathology. Convalescence normal until twenty-one days after operation when his abdomen became moderately distended. The following morning there was marked abdominal distention, and repeated enemas were not effective. The patient did not vomit. On examination, there was no board-like rigidity of the
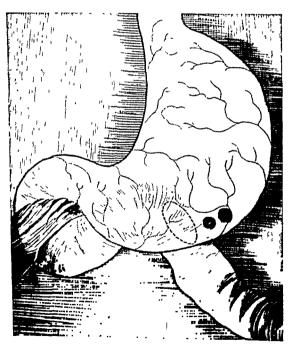


FIG. 1.—Multiple Perforated Gastric Ulcers.

abdomen; no dulness in the flanks; no shifting dulness; slight tenderness present in the lower left quadrant of the abdomen. Patient was very weak. At this time the possibility of an intestinal obstruction was considered, and after consultation the following day, an enterostomy was made.

A large amount of gas was obtained through the tube. There was no evidence of blood or free fluid in the abdomen. Patient returned to his room in good condition.

The following day a blood count showed a decrease in hæmoglobin to 50 per cent., with a corresponding fall in the red blood cells, and the patient was given a blood transfusion of 400 cubic centimetres of whole blood. He reacted slightly, but the next day was very weak and at times irrational. His condition became progressively worse, and he expired on November 22, twenty-four days after operation.

At autopsy there was no evidence of malignancy or obstruction in the intestinal tract. Inspection of the upper abdomen revealed the site of the gastrojejunostomy to be in excellent condition, with no evidence of leaks or adhesions. The stomach, which was three times the normal size, was found adherent to the parietal peritoneum by a large plastic exudate. Inspection of the gastrojejunostomy from the inside revealed that its condition was satisfactory. About two inches to the left of the stoma two clean-cut perforated ulcers, about one centimetre in diameter, were found situated side by side on the greater curvature posteriorly. (Fig. 1.) The stomach contents had burrowed downward and backward in the lesser peritoneal cavity, surrounding the posterior surface of the stomach and giving rise to a low-grade peritonitis found in that area. *Other inspections were negative.*

This case is of special interest because: (1) The stomach was carefully examined at the time of operation and the only ulcer present was located in the duodenum; (2) the patient did not have the typical symptoms of a perforated viscus; (3) the location of the ulcers, which was different from the thirty-three cases found in the literature; (4) in the large majority of the reported cases, the ulcers have been of the "kissing type," that is, one situated on the anterior and one on the posterior wall opposite each other, whereas in this case, the twin ulcers were situated side by side; (5) only thirty-three authentic cases of multiple perforations of gastric ulcers have been reported in the literature.

ROBERT B. DRURY, M.D. *Columbus, O.*

REFERENCE

Masson, J. C. and Simon, H. E.: Multiple Perforated Gastric Ulcers, Case Report and Review of the Literature. Minnesota Medicine, pp. 289–294, May, 1927.

# THE INTRASPINAL USE OF LIPIODOL

THE use of lipiodol intraspinally is still sufficiently new to occupy an unsettled position in the group of standardized methods of spinal investigation. Opinions as to its safety, reliability and convenience are quite divergent, varying from the assurances of Sicard and his co-workers of its entire innocuousness to the complete denial of all claims made for it as a non-irritating substance and the prohibition of its use by at least one clinic in this country. Because of these facts it is obvious that the reporting of cases in which it has been used is still highly desirable for it is only by this means that the true value of the method can be determined.
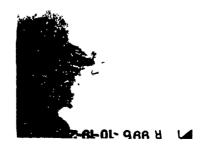


FIG. 1.—Complete "block" with outline of tumor shown by margin of the oil.

In the first of the three cases reported herein two centimetres of the French preparation were injected through the lumbar route. In the second the technic was the same while in the third the only change made was to increase the amount to four cubic centimetres. A previous examination of the spinal fluid had been made in each case and had failed to reveal any evidence of meningeal irritation or infection.
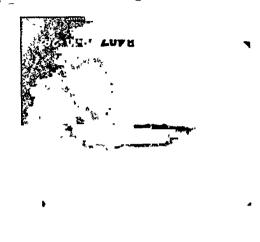


Fig. 2.—Complete "block."

Following the injection the patients were placed in the inverted or Trendelenburg position for about five minutes before the X-ray plates were made. Röntgenograms were again made at the expiration of about half an hour. It is noteworthy that in none of these secondary plates had the position of the opaque material changed. In two of the cases the X-ray examination was repeated the day after the injection, the material failing to move from its caudal position in one case, while in the other practically exact duplicates of the previous plates were obtained. In all three cases there was a slight rise in the temperature the day after the introduction of the lipiodol but on no occasion did it reach 100° F.

Operation and removal of a tumor followed in two of the cases, one within a few days and the other fourteen months after the injection of the oil.

In two of the cases lumbar puncture prior to the use of the lipiodol had resulted in a definite increase in the amount of pain the patients were complaining of. In both of these the introduction of the oil produced no greater increase than had the simple withdrawal of spinal fluid. In the third case neither the simple puncture nor the injection caused any increase in the severity of the symptoms.

At operation no adhesions were found in either case and these three cases certainly showed no ill effects from the use of lipiodol. It served to real purpose in the third case by definitely removing the patient from the danger of having her cord unnecessarily explored.



Fig. 3.—Patient in prone position to show "stringing out" of lipiodol in the absence of a "block" of the canal.

That iodized oil is not necessary for the establishment of the diagnosis in the large majority of cases is obvious, nor is it maintained that it was essential in these cases, particularly the

first two, but it should be equally clear that it is a method that has distinct possibilities in doubtful cases and is not entirely to be dismissed as too dangerous for use.  After all it is certainly better to have a small amount of oil at the bottom of one's caudal sac than to have an unnecessary exploration performed or to carry a tumor that has been overlooked.

ROGER G. DOUGHTY, M.D.
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# BOOK REVIEWS

A TEXT-BOOK OF FRACTURES AND DISLOCATIONS.   By Kellogg Speed, M.D., Second Edition.   Octavo, cloth, pp. 952, 987 illustrations.   Philadelphia, Lea and Febiger, 1928.

The second edition of "A Text-Book of Fractures and Dislocations" has grown to be a volume of 952 pages with 987 illustrations.   It has been thoroughly revised and much new material added.

The edition has been enriched by the lessons learned in the "Great War". The author has digested these, chosen the most practicable ones and has made them available to civil practice.

By improving the topographical arrangement the material has been made more readily available for the student.   With few exceptions the illustrations illustrate.   Simple-line cuts showing the basic mechanical principles underlying the treatment of fractures by suspension, and traction would have been preferable to the photographs crowded with forests of ropes, pulleys and weights.   The graphic representations of the demonstration booths of the Fracture Committee of the American Medical Association are novel and serve a purpose.   The movie-like catch phrases coupled with the illustrations appeal to the visual sense, fixing the ideas better than the written or spoken word.   Fig. 232, page 307, and Fig. 677, page 665, of these demonstrations are misleading.   The resulting forces shown are not such as conduce to mechanical efficiency.   The reviewer understands that the same faults were evident in the actual demonstrations.

The chapter on the general treatment of fractures is sound and full of invaluable advice on what to do and what not to do.   The chapter devoted to "The Operative Treatment of Fractures in General", is an able, practical, and liberal exposition of the underlying principles.   The chapters on the various fractures and dislocations of individual bones and joints are remarkably free from fads and fancies.   The treatment and after-treatment of the various lesions are presented with a fulness balanced by a proper regard for detail.   The advice offered is sound and full of common sense.

It is impossible to please everyone and keep a text-book within practical limits.   Nevertheless, we wish that Doctor Speed had allowed us to share with him his rich pathological experience.   We also feel that the work would have been enhanced by a suitable historical background.   This feature is one of the charms of Stimson's classical work.   A knowledge of what the pioneers in our craft have done and what we owe to them should be readily accessible to all students.   The necessary information should come to them in connection with the subject in which they are working.   It should not be hidden away in a disconnected history.   Such knowledge enhances

the morale of the profession and stimulates the individual to be something more than a mere automaton.

Throughout this monograph a liberal point of view is taken and there is no attempt to throttle ideas by the popular canker of dogmatic standardization. It mirrors the modern American practice of the treatment of fractures and reflects the ripe experience of a surgeon well versed in traumatic surgery.

H. H. M. LYLE.

SINUS THROMBOPHLEBITIS: INFLAMMATORY DISEASES OF THE VENOUS SINUSES OF THE DURA MATER. By Alfred Braun, M.D. 4to. Cloth, pp. 269. New York, Paul B. Hoeber, 1928.

This work is a fairly complete summary of the subject of sinus thrombophlebitis, but naturally, except for the anatomy, deals chiefly with the sigmoid sinus. The first third of the volume is devoted to anatomy, with a small section on embryology and development. Detailed descriptions of all the venous sinuses are given and the numerous variations described. The following third is devoted to pathology and symptomatology. A detailed review, in order, of all the various symptoms is given, and in many instances statistics of various authorities are quoted. However, some are rather lightly passed over, as where the author states "that there is an increase in the total number of leucocytes" notwithstanding that this is not always met with and that there is frequently a leucopenia in children.

The last third is chiefly devoted to the treatment of sigmoid thrombosis. The author describes the standard operation with complete removal of the sinus wall and thrombus, but makes little mention of the variations from this which are now advocated by many otologists. The subject of cavernous sinus thrombosis, both as to symptoms and treatment, is rather briefly reviewed, with frequent reference to Eagleton's work.

Throughout the volume the author rarely mentions his own experiences, and for some reason quotes none of his own statistics, thus giving the volume the aspect of a general and fairly complete review of the subject, rather than a personal authoritative work. Thus the Tobey test, with its modifications, is described, but it is left entirely to the reader to judge if the procedure may be of value.

The volume is profusely supplied with original and well-selected illustrations, which add greatly to the text. As a general survey, the work should prove of value to any otologist both for study and for reference.

ROBERT L. MOORHEAD.

PROCTOLOGY. A Treatise on the Malformation, Injuries and Diseases of the Rectum, Anus and Pelvic Colon. By FRANK C. YEOMANS, M.D. D. Appleton & Co., New York, 1929. Large 8vo; cloth; pp. 661.

In this book, which bears the date of 1929, the effort of the author has been to present a practical view of the knowledge of to-day in the affections

of the particular section of the body to which it is devoted, namely, affections of the lower colon, of the rectum and of the anus. The result is worthy of commendation for the book as a whole covers well the field of surgical effort which the progress of later years has been made to become very large and important.

The systematic treatment of the various subjects involved has been sufficiently detailed to swell the size of the book to a very marked degree and yet examination of its more than six hundred large octavo pages does not show anything which might have been omitted without a distinct loss. The chapters on anatomy, physiology, embryology and developmental defects are excellent and are fundamental. The chapters upon the examination of the patient are thorough and instructive. One cannot help a smile of amusement, however, in noting that in the illustrations devoted to sigmoidoscopy, the examiner is depicted with his face thoroughly protected by an aseptic mask and one wonders whether the use of such a mask at such a time was intended to prevent possible infection of the rectum by nasal secretions or to protect the face from the possible results of too forcible rectal explosions. To say the best, the mask does no harm, anyway.

The great field of the proctologist is undoubtedly that pertaining to the relief of hemorrhoidal conditions. It is to be wished that the anatomy and etiology of these conditions had been more fully elaborated. When it comes to the treatment of hemorrhoids, the author declares himself as most favorable to the clamp and cautery method, saying that he "employs it more than any other operative method and with most satisfactory results". We must confess some surprise at this for we had thought that the trend of more recent surgery had been to send even the hemorrhoidal clamp and cautery back to association with the cauterizing irons of the general surgeon of the days of Paré and to substitute therefor the more ideal methods of direct excision and immediate suture. What little suggestion the author makes toward the latter methods are imperfect and unsatisfactory. This criticism, however, should not prevent one from an appreciation of the value of the many other chapters of the work.

LEWIS S. PILCHER.

THE USE OF BACILLUS WELCHII (PERFRINGENS) ANTITOXIN
IN EXPERIMENTAL GENERAL PERITONITIS
AND INTESTINAL OBSTRUCTION *

By Glover H. Copher, M.D., Caleb S. Stone, M.D.

AND

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THE striking improvement of clinical aspects and the reduction of the mortality rate of acute peritonitis and of acute intestinal obstruction, which was reported by Williams [1] after the use of *Bacillus Welchii* antitoxin, made desirable further investigation of this mode of treatment of the two conditions. If the surgical treatment of peritonitis and of intestinal obstruction can be supplemented by another reliable method, their high mortalities may be reduced. This article is a record of our study by experimental methods of the value of *Bacillus Welchii* antitoxin in acute peritonitis and intestinal obstruction.

Impressed by the clinical similarity between acute intestinal obstruction and general peritonitis and the toxæmia of gas gangrene, Williams investigated the importance of toxæmia due to anaërobic organisms in the first two conditions. *Bacillus Welchii* was chiefly studied since it is the most abundant and constant organism found in the human intestine that is known to produce toxin. Williams found evidence of an immense proliferation of *Bacillus welchii* in the vomitus and in the contents of the small intestine of patients with acute peritonitis and obstruction. He also found evidence of the presence of *Bacillus Welchii* toxin in the contents of obstructed or paralyzed intestine and evidence of the absorption of the toxin from the intestine.

Williams made a therapeutic test of his hypothesis at St. Thomas's Hospital by the administration of *Bacillus Welchii* antitoxic serum in cases of general peritonitis and acute obstruction. A comparison of cases so treated with a control series showed a definite lowering of the mortality and alleviation of the symptoms and clinical signs. *Bacillus Welchii* antitoxin was administered to eighteen of the most severely ill of a series of 256 consecutive cases of peritonitis following acute appendicitis. There were three deaths, making a mortality of 1.17 per cent. A control series of 111 cases at the same hospital which were not given *Bacillus Welchii* antitoxin showed a mortality of 6.3 per cent.

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* Read by title before the Central Society for Clinical Research, November 23, 1928.

*Bacillus Welchii* antitoxin was given in addition to operative relief to fifty-four cases of acute intestinal obstruction and there was a mortality rate of 9.3 per cent. as opposed to the rate of 24.8 per cent. in a series which did not receive antitoxin.

Bower and Clark [2] have reported the clinical use of *Bacillus Welchii* antitoxin at the Samaritan Hospital, Philadelphia, in eleven cases of acute diffuse suppurative peritonitis, nine cases of acute intestinal obstruction and five cases of acute suppurative cholecystitis. These authors have substantiated in this small number of patients the claims made by Williams. The patients suffering from peritonitis and intestinal obstruction who were treated with antitoxin were less restless, the pulse rate was diminished, the temperature was reduced, abdominal distention became less and bowel movements were begun earlier.

*Experimental Methods and Results.*—The first part of our experimental study was made by comparing the mortality rate in a control group of dogs suffering from acute peritonitis with the mortality rate in a similar group that were treated with *Bacillus Welchii* antitoxin. In fourteen dogs used as controls, the abdomen was opened under ether anæsthesia with aseptic precautions. The appendix was identified and together with the meso-appendix was ligated at its base. After closure of the abdomen, the dogs were replaced in cages and the day of death was recorded. In the experimental series of fourteen dogs, this same operative procedure was performed, but in addition, they were treated with *Bacillus Welchii* antitoxin.

TABLE I.—CONTROL SERIES

Four of the fourteen dogs survived ligation of their appendices. The average length of life of the remaining ten dogs was 4.2 days.

| Dog Number | Length of life in dogs |
|---|---|
| 1 | Alive |
| 2 | 2 |
| 3 | 12 |
| 4 | 3 |
| 5 | Alive |
| 6 | 3 |
| 7 | Alive |
| 8 | 4 |
| 9 | 2 |
| 10 | 2 |
| 11 | Alive |
| 12 | 4 |
| 13 | 8 |
| 14 | 2 |

In the control series of fourteen dogs (Table I), in which peritonitis was established by making the appendix gangrenous, four dogs recovered spontaneously. The average duration of life of the remaining ten dogs was 4.2 days. Post-mortem examination of the ten dogs that died revealed in each instance an acute general peritonitis. Examination of the four dogs that sur-

vived a few weeks until sacrificed showed evidence of having had an extensive peritonitis.

In the experimental series of fourteen dogs treated with *Bacillus Welchii* antitoxin,* four recovered. (Table II.) The average length of life of the ten dogs which died was 5.3 days. The dogs were given, during the first or second post-operative days when the animals became very ill, an initial dose of *Bacillus Welchii* antitoxin which averaged 1.7 cubic centimetres per kilogram body weight. This dosage is in proportion to the amount given to patients by Williams. The initial dose was followed by a daily intramuscular dose of one-half to one cubic centimetre of *Bacillus Welchii* antitoxin per kilogram body weight.

TABLE II.—EXPERIMENTAL SERIES

Fourteen dogs with an experimentally produced peritonitis were treated with Bacillus Welchii antitoxin. Four dogs survived. The average length of life of the remaining ten dogs was 5.3 days.

| Dog No. | Length of life in dogs | Anaërobic cultures | | | Wt. of dog per kilo | Dose of B. Welchii antitoxin | |
| | | Peritoneal cavity | Abscess about appendix | Distended loop of intestine | | Initial | Daily |
|---|---|---|---|---|---|---|---|
| 15 | 17 sacrificed | — | — | — | 20 | 54 cc. | 18 cc. |
| 16 | 3 | — | — | — | 10 | 30 cc. | — |
| 17 | 8 | — | — | B. Welchii | 7.6 | 13 cc. | 4.2 cc. |
| 18 | 3 | B. Welchii | — | B. Welchii | 4.3 | 8 cc. | 5 cc. |
| 19 | 9 | Culture not taken | Culture not taken | Culture not taken | 3.1 | 6 cc. | 5 cc. |
| 20 | 2 | — | — | B. Welchii | 5.8 | 15 cc. | — |
| 21 | 4 | — | — | — | 4.6 | 15 cc. | 8 cc. |
| 22 | 2 | B. Welchii | B. Welchii | B. Welchii | 3.6 | 10 cc. | — |
| 23 | 31 sacrificed | — | — | — | 11 | 19 cc. | 10 cc. |
| 24 | 17 sacrificed | — | — | — | 6.6 | 11 cc. | 4 cc. |
| 25 | 8 | — | — | — | 4.4 | 7.5 cc. | 2.5 cc. |
| 26 | 5 | — | — | — | 5 | 10 cc. | 3.5 cc. |
| 27 | 9 | — | B. Welchii | — | 8 | 13 cc. | 5 cc. |
| 28 | 17 sacrificed | — | — | — | 6 | 10 cc. | 4 cc. |

Anaërobic cultures were taken at autopsy from the peritoneal cavity, from the region about the appendix and from a distended loop of intestines of the ten dogs. *Bacillus Welchii* were recovered from one or the other of these sites in five instances.

The second portion of our investigation is concerned with the value of *Bacillus Welchii* antitoxin in the treatment of experimental intestinal obstruction and peritonitis. A rapidly fatal lesion was established by making a short isolated loop high in the intestinal tract. Under ether anæsthesia with careful asepsis, the abdomen of the fourteen dogs in the control series was opened

* The antitoxic serum used in the experiments was prepared from the blood plasma of horses immunized against the toxin of *Bacillus Welchii* or *Bacillus perfringens*.

and at a uniform distance of 45 centimetres from the pylorus an isolated loop 15 centimetres in length was made. Care was taken not to damage the blood supply of the loop of the intestine. An end-to-end anastomosis was made of the proximal and distal ends of the intestine. The abdomen was closed without drainage. Death followed rather quickly in each instance. The average duration of life of the fourteen dogs in this control series was 2.3 days (Table III). A post-mortem examination of each dog revealed a rupture of the obstructed loop and a general peritonitis. Undoubtedly the obstruction of the intestine played an important part in the fatality of the animals.

TABLE III.—CONTROL SERIES

The average length of life of fourteen dogs with a short isolated high jejunal loop was 2.3 days.

| Dog Number | Length of life in dogs |
| --- | --- |
| 29 | 3 |
| 30 | 3 |
| 31 | 3 |
| 32 | 1 |
| 33 | 2 |
| 34 | 2 |
| 35 | 2 |
| 36 | 1 |
| 37 | 2 |
| 38 | 5 |
| 39 | 3 |
| 40 | 2 |
| 41 | 2 |
| 42 | 2 |

The same type of operation was performed upon an experimental series of fourteen dogs. Five of the dogs received *Bacillus Welchii* antitoxin the morning following operation and nine of them received the antitoxin immediately after operation. An average daily dose of 1.7 centimetres of *Bacillus Welchii* antitoxin per kilogram body weight was administered. The first dose was given intravenously and the rest of them were given intramuscularly. In the experimental series of fourteen dogs, all of which died, the average length of life after operation was 4.6 days. (Table IV.) The isolated loop of intestine was found intact at autopsy in ten of the fourteen dogs. Anaërobic cultures were made from inside the intact isolated loop or from the free fluid in the peritoneal cavity and *Bacillus Welchii* was grown in twelve of the fourteen cultures.

*Discussion.*—Although there is some disagreement among clinical and experimental investigators regarding the exact nature, mode of formation and action of toxic substances concerned with ileus and intestinal obstruction, it is our belief that anaërobic, as well as aërobic, bacteria play a rôle in the production of the toxaemia found in the two conditions. This belief is substantiated by the fact that life was prolonged in the experimental series of dogs having acute general peritonitis and acute intestinal obstruction by the

use of *Bacillus Welchii* antitoxin. The average prolongation of life in the group of animals suffering with general peritonitis that were treated with antitoxin over the control group that did not receive treatment is not long. However, the results obtained in the second group of experiments are more suggestive of a therapeutic efficacy for *Bacillus Welchii* antitoxin, in the treat-

TABLE IV.—EXPERIMENTAL SERIES

The average length of life of fourteen dogs having an experimentally produced intestinal obstruction, and which were treated with Bacillus Welchii antitoxin, was 4.6 days

| Dog No. | Days of life after operation | Autopsy findings | Culture from loop | Antitoxin administered |
|---|---|---|---|---|
| 43 | 2 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day following operation |
| 44 | 2 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day following operation |
| 45 | 3 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day following operation |
| 46 | 3 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day following operation |
| 47 | 3 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day following operation |
| 48 | 4 | Loop not ruptured Free fluid in abdomen | B. Welchii | Day of operation |
| 49 | 6 | Loop ruptured General peritonitis | Negative for B. Welchii | Day of operation |
| 50 | 7 | Loop not ruptured General peritonitis | B. Welchii | Day of operation |
| 51 | 5 | Loop not ruptured General peritonitis | B. Welchii | Day of operation |
| 52 | 7 | Loop not ruptured General peritonitis | Negative for B. Welchii | Day of operation |
| 53 | 4 | Loop ruptured General peritonitis | B. Welchii | Day of operation |
| 54 | 6 | Loop not ruptured General peritonitis | B. Welchii | Day of operation |
| 55 | 5 | Loop ruptured General peritonitis | B. Welchii | Day of operation |
| 56 | 8 | Loop ruptured General peritonitis | B. Welchii | Day of operation |

ment of acute intestinal obstruction. The average duration of life of 2.3 days in this control series was increased by the early administration of antitoxin to 4.6 days in the experimental series. It may be significant that in the group with intestinal obstruction where *Bacillus Welchii* antitoxin was most efficacious that *Bacilli Welchii* were most frequently recovered from cultures made

from the loops of intestine. Definite prolongation of life in this series began when the time of injection of the antitoxin was changed from the day following the operation to the day of operation.

## CONCLUSION

It is suggested by our experimental work and by the previous work of Williams that the medical profession is warranted in making a further clinical trial of *Bacillus Welchii* antitoxin as an adjuvant in the treatment of acute general peritonitis and acute intestinal obstruction. The early and adequate administration of the antitoxin should supplement, in addition to surgical intervention, other well established methods of treatment of these two diseases, such as lavage of the patient, the copious administration of saline and dextrose solutions to combat hypochloræmia, starvation and dehydration.†

There has also come to our attention an unpublished article by Owings and McIntosh on "Perfringens Antitoxin and Experimental Intestinal Obstruction." They have concluded (1) that the life of dogs with high intestinal obstruction is not prolonged by the use of bacillus perfringens antitoxin; (2) that neutralization of the toxic substance contained in a closed loop is not affected by *Bacillus perfringens* antitoxin either *in vitro* or *in vivo;* (3) that a minimal lethal dose of loop toxin is fatal to dogs immunized to the toxin of *Bacillus Welchii.*

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[1] Williams, B. W.: The Importance of Toxæmia Due to Anaërobic Organisms in Intestinal Obstruction and Peritonitis. Brit. Journal of Surgery, vol. xiv, p. 295, 1927.

[2] Bower, G. O., and Clark, Jefferson: Bacillus Welchii (Perfringens) Antitoxin—Its Therapeutic Values. A Preliminary Report Based on the Treatment of Twenty-five Cases. Am. Journ. Med. Sc., July, vol. clxxvi, p. 97, 1928.

† Since the completion of this article there has been published an article by J. J. Morton and S. T. Stabins (Relation of Bacillus Welchii Antitoxin to the Toxæmia of Intestinal Obstruction, Arch. of Surgery, volume xvii, p. 860, 1928), in which the authors report experimental evidence that the antitoxin of *Bacillus Welchii* has a specific action in the relief of intestinal obstruction in dogs.

# THE RÔLE OF THE BACILLUS WELCHII IN ACUTE INTESTINAL· OBSTRUCTION

## WITH LIGATION OF THE VEINS TO THE OBSTRUCTED LOOP

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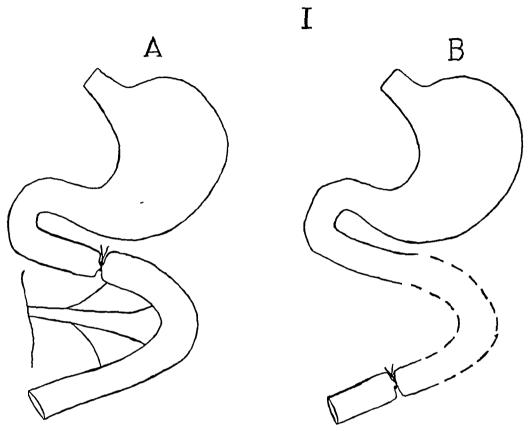
*Introduction.*—In 1926 Williams [1] advanced the hypothesis that the toxæmia in cases of intestinal obstruction, whether of organic origin or secondary to peritonitis, is due at least in part to the absorption of the toxin of *B. Welchii* from the obstructed bowel. In support of his theory he cites certain points of similarity between the clinical pictures of intestinal obstruction and of gas bacillus infection, and the fact that he finds *B. Welchii* in large numbers in the contents of the obstructed intestine and in the vomitus from these cases. On the basis of this theory, he gave *B. Welchii* antitoxin to two heterogeneous groups of patients suffering from intestinal obstruction or peritonitis, with an apparently favorable effect upon the course of the disease and with a lowering of the mortality rate. Bower and Clark [2] in a recent article report a series of twenty-five cases of intestinal obstruction or peritonitis treated with *B. Welchii* antitoxin, and they also consider that its administration favorably influenced the course of the two diseases.

The experiments presented in this report were carried out in an attempt to obtain more definite information upon the importance of the *B. Welchii* as the cause of the symptoms accompanying intestinal obstruction. In these experiments cats were used as the laboratory animal. Studies were made on the course of events during the survival period following the production of intestinal obstruction. All the animals were autopsied, and bacteriological studies were carried out. The toxicity of different strains of *B. Welchii* isolated from the obstructed loops was tested; the susceptibility of the cat to *B. Welchii* was determined; and finally the effects of administering *B. Welchii* antitoxin were studied.

*Types of Intestinal Obstruction.*—It is essential to realize that the subject of intestinal obstruction is a broad one and that different types of obstruction produce quite different results, as regards both the clinical course and the pathological picture. In general, three main types of obstruction that are quite distinctive have been used in experimental work upon the problem of acute intestinal obstruction (Figs. I, II or III) ; first, simple blockage of the bowel high in the gastro-intestinal tract; second, closure of a loop of bowel (with or without reëstablishment of the continuity of the gastro-intestinal

tract by anastomosis) ; and, third, obstruction of a loop complicated by gross interference with the venous return from the bowel. It has recently been shown [3, 4, 5, 6] that it is questionable whether the first type of obstruction causes any true toxæmia, since the symptoms may all be attributed to the great loss of water and electrolytes in the vomitus [*]; it is extremely unlikely,



Figs I, II and III show in diagrammatic form the main types of acute intestinal obstruction most frequently employed in experimental work   There are, of course, many minor modifications of technic I —Simple blockage   A, high in the intestinal tract, B, in the lower portion of the ileum   Type A is characterized by profuse vomiting which results in severe dehydration due to the loss of water and of the electrolytes, sodium and chloride   It is questionable whether with this type of obstruction there is any true toxæmia   Type B is not used very frequently   Animals with this form of obstruction have a much longer survival period, vomiting is not likely to occur so soon or to be so profuse. Since kinking of distended coils of the small intestine prevents free drainage back into the stomach, a series of semi isolated loops may result and this type of obstruction thus tends to merge with the second major type described in Fig II

therefore, that the *B. Welchii* could play any rôle in this type of obstruction. In the other two types it seems most likely that a true toxæmia does occur, and that the *B. Welchii* might, therefore, be an etiological factor.

For the purposes of this study, three points led us to select the third type of obstruction—namely, a closed loop of bowel with the veins leading to the obstructed segment ligated. In the first place, as shown by Murphy and Vincent,[8] this type of obstruction is the most rapidly fatal and thus is presumably accompanied by the most severe toxæmia; in the second place,

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[*] It is assumed that the obstruction is at such a high level that free drainage back into the stomach occurs.  As pointed out by Hartwell and Hoguet,[7] the stomach should be kept empty and not allowed to dilate.

since the animals live such a short time, little fluid and sodium or chloride ions can be lost in the vomitus, and their deficiency may therefore be ruled out as a cause of symptoms; in the third place, as shown by McIver, Redfield and Benedict,[9] excellent anaërobic conditions obtain following the ligation of the veins to the intestines. It seemed reasonable, therefore, to consider that if the B. Welchii played a rôle in the pathology of any form of acute intestinal obstruction, they would be most active in this type which is so severe and which furnishes such ideal conditions for their multiplication.

*Method of Producing Obstruction.*—Cats were used in all of these



Fig. II.—An isolated loop: *A*, with reëstablishment of the continuity of the intestinal tract; *B*, without reëstablishment of continuity. These isolated loops are usually constructed in the upper portion of the small intestine. Serious symptoms develop early. The amount of dehydration and loss of chlorides depends upon the amount of vomiting and the length of the survival period. Usually the animals do not survive long enough for the changes in the body fluids to become important.

experiments, the operations being carried out under full ether or chloralose anæsthesia. The method of producing the obstruction was as follows: after anæsthetization, the abdomen was opened; a loop of intestine about thirty centimetres distant from the pylorus was selected and the lumen obstructed by a ligature tied around the bowel; at a point about twenty centimetres distal to this, a second ligature was tied around the bowel; the veins leading to the obstructed loop were then ligated with fine silk, great care being taken not to include arteries, nerves or lymphatics. This preparation is similar to that used by Murphy and Vincent[8] and resembles in certain respects that of

Foster and Hausler;[10] many of the observations given below have been reported by the above authors, but we have repeated certain of their experiments for the sake of completeness.

*Results of Obstruction. Course of Events during Survival Period.* —The survival period of the cats with this type of obstruction was usually between eighteen and thirty-two hours. The animals made a good recovery from the ether anæsthesia and the operation, and showed no striking symptoms during the first twelve hours. A few of them vomited a small amount, but as this was never a prominent symptom their blood chlorides, as might be predicted, were not lowered (Table I), and consequently their life could not be appreciably prolonged by the administration of salt solution. Near the end of the survival period, the animals showed increasing apathy and asthenia; there was marked pallor of the buccal mucous membranes; rectal temperature readings were usually below normal, and the muscles showed some loss of tone. In certain instances the white blood cells were greatly increased, while in others they were normal; the capillary red blood cell count was usually somewhat higher than that taken from the venous blood—in a typical instance the capillary count was 7,000,000, the venous 6,500,000. Near the end of the



Fig. III.—An isolated loop with ligation of its veins. It is this type of obstruction which is employed in the experiments described in this paper. As pointed out by Murphy and Vincent, this is the most serious and fulminating of the different types. Its clinical counterpart is found in cases of intussusception, volvulus, et cetera. Here, again, the dehydration and loss of chlorides are not of importance. (See Table I.)

period the blood pressure was below normal; the blood volume was determined in one instance by the vital red method and was found to be distinctly low. The clinical picture presented by these animals is characteristic of a profound toxæmia and is consistent with that produced by a *B. Welchii* infection.

TABLE I.

| | A Intestinal Obstruction with Ligation of the Veins to the Obstructed Loop | | | | | | | B Simple Blockage of the Intestine | | | C Control |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cat. No......... | 1 | 2 | 4 | 6 | 7 | 9 | 33 | 5 | 5 | 5 | Average of four normal cats |
| Time post-operative | 32 hrs. | 22 hrs. | 24 hrs. | 22 hrs. | 18 hrs. | 19 hrs. | 20 hrs. | At operation | 2 days | 4 days | |
| Blood Cls (mgms. per 100 c.c. serum). ...... | 632 | 768 | 570 | 649 | 642 | 689 | 673 | 700 | 518 | 482 | 698 |

*A.*—In the type of obstruction used in these experiments, vomiting is a negligible symptom; therefore, as might be predicted, no lowering of the blood chlorides is found.

*B.*—Here, for the sake of contrast, the lowering of the blood chlorides that occurs in simple high blockage of the intestine, where vomiting is of course profuse, is shown. In this type of obstruction we believe the loss in the vomitus of water and the electrolytes, sodium and chloride, is largely responsible for the death of the animal.

*C.*—The average figure for the blood chlorides of four normal cats is shown.

*Autopsy Findings.*—Autopsy was carried out immediately after death on animals dying of obstruction, and was also performed on a number that were sacrificed by ether anæsthesia from seven to twenty-two hours after operation. The typical findings eighteen to twenty-four hours post-operative were as follows. The peritoneal cavity always contained a rather thin, bloody fluid, varying in amount from thirty to sixty cubic centimetres; if allowed to stand this formed a firm clot; smear preparations of the fresh fluid showed numerous red and white blood cells and occasional organisms. There was no purulent peritonitis. The peritoneal surface of the obstructed loop was usually smooth and glistening; occasionally it had lost its lustre and showed a thin coating of fibrin over the surface. The mesentery of the obstructed loop was œdematous; the obstructed veins were dark in color, distended and thrombosed; the lymphatics were beautifully outlined, being distended with red blood cells and with lymph discolored by hæmolysis; the lymph glands draining the loop were also discolored by disintegrated red blood cells. On opening the thoracic cavity the thoracic duct was usually found to contain blood-stained fluid that on smear showed red and white blood cells. The

loop itself was black in color, distended and tense.† The pressure in the loop was high, readings up to fifty-four millimetres of mercury being obtained by inserting a glass cannula connected with a mercury manometer; the content was made up of from thirty to fifty cubic centimetres of thick, bloody exudate and usually two to three cubic centimetres of gas, rarely as much as twenty to thirty cubic centimetres of gas being found. When the exudate was centrifuged, the particulate elements were found to constitute about 40 per cent. of the total volume; smears showed red blood cells, leucocytes and enormous numbers of organisms. Sections of the wall of the loop, fixed in Zenker's solution and stained with Giemsa, showed considerable disintegration of the normal structure, the mucosa in particular having undergone almost complete degeneration; large numbers of organisms were present in the fragments of mucosa and in the degenerated muscle layers.

*Cultural Studies.*—Cultural studies of the bacterial flora of the obstructed loops in twenty-eight cats gave quite constant results. There was no noteworthy increase of any organisms of the aerobic group; but the numbers of *B. Welchii* were always increased, even to the extent, in one loop, of constituting 82 per cent. by actual count of the vegetative forms present. In no case was there any doubt but that *B. Welchii* was the predominant organism. So far, this confirms the work of Williams, who found an enormous number of *B. Welchii* in the intestinal contents and vomitus of patients with acute intestinal obstruction. Since, however, the *B. Welchii* is found normally in the small intestine of humans and many other animals, the fact that it can be obtained in large numbers from the bowels and at times from the peritoneal cavity of animals with intestinal obstruction by no means

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† The course of events after the ligation of the veins was found to be as follows. The color of the loop changed immediately from a light pink to a dusky red, which in turn soon became dark mahogany-red or black. The peritoneal surface remained smooth and glistening. Coincident with the color changes, active movements started up in the obstructed loop; these for the most part took the form of intense tonic contractions of the whole loop or of isolated segments. At times, in addition to these movements, strong waves of peristalsis swept over the loop and in a number of instances definite waves of reverse peristalsis were noted. Vigorous contractions of the loop usually continued for a number of hours.

Distention of the loop occurred within a short time after the obstruction was produced: in certain of the experiments a glass cannula connected with a mercury manometer was inserted into the loop, and after the lapse of a few hours pressure readings as high as fifty-four millimetres of mercury were obtained. If the loop was opened at this time it was found distended by a thick, reddish-colored exudate, composed largely of blood cells and serum which had been poured into the loop as the result of capillary damage caused by high venous pressure and inadequate supply of oxygen.

The above observations were carried out under chloralose anæsthesia in a moist chamber devised and described by Veach.[11] This piece of apparatus consists of a copper box large enough to receive a cat extended on an animal board; the bottom of the box contains water warmed by an electric heating coil; the lid is supplied with glass windows for the purpose of observation, and small apertures permit the insertion of thermometer, cannulæ, etc.

Dr. Harold Myers assisted in making these observations.

proves that it is a factor of importance in producing the symptoms of this disease. On a somewhat similar basis it has been considered [12] the etiological agent in pernicious anæmia; the work of Nye,[13] however, has shown that the increased numbers of this bacillus in the stools of patients with pernicious anæmia are merely secondary to the gastric anacidity which accompanies the disease and that the organism is probably of no etiological significance.

In a number of instances the cultures of the peritoneal exudate also showed *B. Welchii.* We were also able to demonstrate this organism in several anaerobic blood cultures and once from the lymph of the thoracic duct. There seemed no doubt of the fact that its presence in the blood, lymph and peritoneal exudate was merely a post-mortem invasion of these fluids or an ante-mortem phenomenon in a moribund animal.

*Toxicity of Cultures.*—It is well known that different strains of *B. Welchii* show marked variations in their ability to produce toxin, and the following studies were carried out to determine the exact extent of these variations in the organisms isolated from the obstructed loop. Fourteen strains were used in an endeavor to determine their toxicity. Each strain was grown in cooked meat broth of Ph. 7.5. After twenty-four hours' incubation, the cultures were removed from the incubator and at once placed in a refrigerator at 4° C. Filtration through Berkefeld-N candles was carried out at this temperature, in the effort to obtain a toxic filtrate. This filtrate was injected intraperitoneally into mice.

Eight of the fourteen strains were entirely devoid of demonstrable toxicity for these mice, in volumes which could be mechanically tolerated by them. Of the six strains developing toxin, two produced a filtrate of which 0.4 cubic centimetres was the lethal dose for a twenty-gram mouse. This toxicity remained fairly constant after six cultural generations, and compared favorably with that elaborated by a strong toxin-producing stock strain which was invariably fatal to mice in doses of 0.3 cubic centimetres and occasionally 0.25 cubic centimetres. The other strains produced toxin lethal to mice in doses of 0.6, 0.8, and 1.4 cubic centimetres, respectively.

It is not surprising to find such a large number of avirulent strains, and it seems from our observation of clinical cases to be particularly characteristic of the strains of *B. Welchii* isolated from the faeces and from wounds of the perineum and adjacent localities where the organisms produce little or no toxin and cause no clinical symptoms of infection.

*Susceptibility of the Cat to B. Welchii Toxin.*—It is well known that different species of animals show considerable variation in their susceptibility to the toxin of *B. Welchii.* In the literature we could find no work showing the sensitiveness of the cat to this toxin, and in order to obtain data on this point the following experiments were carried out.

A virulent stock strain of *B. Welchii* was grown for twenty-four hours on cooked meat media; the culture was filtered, and 0.3 cubic centimetres of the filtrate was found sufficient to kill a twenty-gram mouse in eighteen

hours. A cat weighing 1.2 kilograms was selected, and the filtrate containing the toxin was injected into the thigh muscles in doses of 4 cubic centimetres and 10 cubic centimetres on two successive days. The animal showed no ill effect from these massive doses of toxin. Six days later a third dose of 12.5 cubic centimetres of toxin was administered, without producing symptoms.

In a second series of experiments, cats weighing about 3 kilograms were etherized and the femoral artery connected with a mercury manometer. The femoral vein on the opposite side was then cannulized and the *B. Welchii* toxin, prepared as described above, was injected in doses of from one to eight cubic centimetres. A fall in blood pressure varying from thirty millimetres to sixty millimetres of mercury occurred, the pressure promptly returning to normal in the course of a few minutes. It was suspected that this transient fall in blood pressure was due not to the *B. Welchii* toxin but to the meat extractives contained in the broth. This was found to be the case, for when sterile cooked-meat broth was given, a fall in blood pressure was noted similar to that obtained with the broth which did contain the toxin. Blood pressure readings on the animals which had received the toxin were carried out for a number of hours. The pressure was well maintained and the animals appeared to suffer no ill effects from the toxin they received.

It would appear from these experiments that the cat is at least relatively immune to the toxin of *B. Welchii*.‡

*Results of Administration of B. Welchii Antitoxin.*—If the *B. Welchii* played a rôle of importance in causing the death of animals with the type of

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‡ Although the above studies appeared to show conclusively that the cat is relatively immune to the toxin of *B. Welchii*, it seemed worthwhile, in order to obtain additional evidence as to whether the *B. Welchii* were responsible for the toxæmia, to supplement these experiments by intravenous injections into normal cats of the peritoneal exudate and loop contents of animals dying of the obstruction.

Eighteen to twenty-four hours after the production of the obstruction the animals were etherized (in the great majority of cases the animals were moribund at this time), the abdominal cavity opened, the peritoneal exudate drawn off, and the contents of the obstructed loop obtained. A normal cat was now etherized and the femoral artery connected with a kimograph for recording blood pressure readings. The femoral vein was then exposed and a cannula inserted. Through this cannula the following materials, obtained from the animal with intestinal obstruction, were injected and the effect on the blood pressure noted. The first injection was of peritoneal fluid; the second, the contents of the obstructed loop. The third type of material injected consisted of the following fractions of the loop contents: (*a*) the sediment resulting from high speed centrifugation carried on for one hour; (*b*) the supernatant fluid; (*c*) the Berkefeld filtrate. The fourth type of material injected was a "dialysate" of the loop obtained by removing the obstructed loop from the animal, suspending it in physiological salt solution and placing it in the incubator for two hours. The results of the injections were as follows.

The peritoneal fluid was injected in four experiments in amounts from one cubic centimetre to twenty-five cubic centimetres. In only one instance was there a slight fall in blood pressure of the recipient. This fluid may thus be considered essentially non-toxic.

obstruction under consideration, it would seem that life might be prolonged by the administration of antitoxin. This was carried out on five cats, but we could not find that life was at all prolonged by its use, except possibly in one instance. The procedure was as follows. Under ether anæsthesia the obstruction was produced as in the other experiments. Just before closing the peritoneal cavity, forty cubic centimetres of the antitoxin was injected intraperitoneally. The antitoxin injected was the perfringens antitoxin (double strength) manufactured by H. K. Mulford Company. The amount injected is stated to contain eighty units; one unit is sufficient to neutralize 1,000 MLD of Welch bacillus toxin; "MLD" is the minimum lethal dose of toxin that will kill a 300-gram pigeon. The dose of antitoxin recommended for humans is about forty cubic centimetres to eighty cubic centimetres; so it is evident that the amount used in the present experiments should have been adequate. This antitoxin should give protection against both the true toxin and the hæmolysm produced by the B. Welchii, but would have no effect on the non-antigenic false toxin described by Kojima[14] and others.

The animals were operated upon in the afternoon. The following morning a second injection of forty cubic centimetres of the antitoxin was made intramuscularly. This was not done in the case of two of the animals that were obviously moribund the morning following operation. The animals lived twenty-nine, eighteen and one-half, twenty-two, twenty-four and fifty-one hours, respectively. These times represent the usual length of life in the untreated animals, with the exception of the animal last mentioned, where the survival period was fifty-one hours. It was not noticed in any

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The crude loop contents were found to be highly toxic, as shown by a profound fall in blood pressure; in certain experiments, 0.3 cubic centimetres were found sufficient to cause the death of the recipient. As would be expected, there was some variation in its toxicity; in one or two instances it was relatively low.

The sediment obtained by centrifugation was highly toxic. The supernatant fluid varied considerably in toxicity, at times producing a fall in blood pressure but at other times producing none, even though both the crude loop contents and the sediment from the same animal were very toxic. In other words, it would appear that for the most part the toxicity of the loop contents depends on the particulate matter. Our findings in this respect are in accordance with those of Murphy and Vincent.[8]

Because of the large amount of particulate matter and the viscosity of the fluid, it is difficult to obtain a satisfactory Berkefeld filtration. Our technic was as follows: The crude loop contents were placed in test tubes containing a few cubic centimetres of 2 per cent. sodium citrate, to prevent clotting, and equal volumes of salt solution were added; this material was then filtered through coarse filter paper and the filtrate was passed through a medium Berkefeld filter. The resulting filtrate was found to have no depressor effect on blood pressure.

The "dialysate" was found to have a decided depressor effect. Its toxicity was not destroyed by boiling for five minutes; and since the toxin produced by B. Welchii is destroyed by heat, it would seem that whether it were bacterial in origin or whether it arose from the split protein products of the degenerating intestinal wall, at least the B. Welchii played no rôle in its production.

of the other animals that the administration of the antitoxin favorably influenced the course of the disease in any way. It might be urged that since the obstruction was not relieved in this series of animals before the administration of antitoxin, it would not be expected to save the life of the animals. This is admitted; but it does seem reasonable to suppose that if the *B. Welchii* toxin were playing the dominant rôle as the cause of death, the lives of more of these animals might have been appreciably prolonged by the administration of antitoxin in such large quantities.

*Discussion.*—It seems to be universally agreed that intestinal obstruction produced by isolating an intestinal loop and ligating its veins is characterized by a high degree of toxæmia. The cause of this toxæmia has long been a controversial point, the two principal theories being, first, that it results from bacterial action; and, second, that it is due to the split protein products of the degenerating intestinal wall. The present study is not concerned with the cause of toxæmia, except in so far as *B. Welchii* does or does not play a rôle.

In view of our studies it is unquestionable that the *B. Welchii* are present in enormous numbers in the obstructed loop. All our attempts, however, to find positive evidence that they play a rôle in causing the symptoms of the disease have been unsuccessful: the experimental animal (the cat) rapidly developed a severe toxæmia following the obstruction of the loop and yet was relatively immune to the *B. Welchii* toxin; the organisms cultured from the obstructed loop consisted largely of avirulent or relatively avirulent strains; and, finally, massive doses of *B. Welchii* antitoxin were without any appreciable effects in four out of the five instances in which it was administered. On the clinical side, Williams,[1] and Bower and Clark[2] have felt that improvement did follow the use of the antitoxin. Before this opinion can be established, however, it will be necessary to select two series of cases with comparable types of intestinal obstruction, giving antitoxin to one series only and otherwise treating them by similar methods. The virulence of the strains of *B. Welchii* that are isolated should also be carefully studied, for the mere presence of the organism unless it is virulent means little or nothing.

## SUMMARY

1. The type of obstruction used in these experiments was a closed loop of intestine with its veins ligated; the cat was used as the experimental animal.

2. The *B. Welchii* were found in enormous numbers in the obstructed loop. For the most part these consisted of avirulent or relatively avirulent strains.

3. The cat is relatively immune to *B. Welchii* toxin, although readily succumbing to the toxæmia of the type of obstruction here considered.

4. We were unable to demonstrate that the administration of *B. Welchii* antitoxin prolonged the life of the animals.

## CONCLUSION

In the type of obstruction under consideration, and with the experimental animal used in these studies, the *B. Welchii*, although found in enormous numbers in the obstructed loop, did not play an important rôle in the production of the fulminating toxæmia. There is evidently here some other and more important factor at work. Caution must thus be used in accepting the importance of *B. Welchii* as an agent in the types of intestinal obstruction in humans characterized by a toxæmia, and the use of the *B. Welchii* antitoxin in the treatment of such cases must be considered still in the experimental stage.

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# SOME CLINICAL FINDINGS IN SUBTOTAL GASTRECTOMY *

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Subtotal gastrectomy is obviously an indefinite term. It has come to be associated, however, with the removal of at least one-third of the stomach. Since Billroth's first successful pylorectomy in 1881, all the possibilities of resection of the stomach and anastomosis with the duodenum and jejunum have been developed to the limit of technical ingenuity. Until a few years ago subtotal gastrectomy was an operation reserved for operable or suspected malignancy and a few unusual or extensive gastric ulcers, and gastro-enterostomy was the operation of choice for ulceration of the stomach or duodenum.

Two years ago in this Academy John N. T. Finney [1] delivered an address which reviewed the forty-five-year period since Billroth's success, and in this paper he discussed at length all the various theories as to etiology and treatment of gastric and duodenal ulcer, and the various types of operative relief with the advantages and disadvantages of each. I cannot do better than to refer you to this masterly work, as tonight I wish to confine myself to the findings, from the functional and physiological viewpoint, of subtotal gastrectomy as encountered on a general surgical service. This operation until the last decade was simply a mechanical method of removing a lesion benign or malignant, but since the war period the surgeons of Austria and Germany, particularly von Haberer [2] and Finsterer,[3] have used it as a means of altering the physiology of gastric secretion, the removal of the lesion being a somewhat minor consideration.

It is generally conceded that although the acid-forming cells are mostly in the fundus, hydrochloric acid is not produced in quantity without an impulse arising from the pyloric third of the stomach. Irrespective of what factor is accepted as being primary in ulcer formation, hydrochloric acid is rather widely credited with being a source of irritation, that is, an obstacle to healing and a cause of recurrence. The continental surgeons have proceeded on this basis and claim that a subtotal gastrectomy with removal of at least one-third of the stomach is effectual in producing achlorhydria, or at least a marked diminution of hydrochloric acid with the dual result of removal of the ulcer-bearing area and the prevention of recurrence.

Surgeons in this country have been somewhat lukewarm in adopting subtotal gastrectomy as the operation of choice in gastric ulcer, and almost unanimous in rejecting it as routine treatment for duodenal ulcers. The Mount Sinai staff of this city is a notable exception. This marked division of opinion between careful and conscientious surgeons is of course temporary.

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Post-operative results followed for a long period will determine the issue, for theoretical objections will naturally fade away before actual statistical proof.

Von Haberer and Finsterer have been publishing their results since 1922 and apparently demonstrated a low mortality and a high percentage of cures, but their publications do not include the statistical details that carry conviction. Dr. Henry Louria [4] recently published the results of a year's attendance at von Haberer's clinic, with a study of the follow-up system and the results covering the period from January 1, 1925, to January 1, 1927. There were 197 cases followed out of a total of 257. A letter was considered a successful follow-up. Out of a total of eighty-one gastric ulcers there were replies from fifty-four. Gastric secretion was determined one half hour after intake of tea and a roll, but no figures are given as to post-operative findings. As you know von Haberer removes from one-half to two-thirds of the stomach and reëstablishes the lumen by a gastric-duodenostomy, end to side. This is also Finney's method.

This careful study by Louria indicated that the follow-up system in this very large clinic is inadequate as a basis for convincing statistics.

Let me review briefly the arguments for and against this operative procedure. Conservatives complain that the operation is too mutilating; that the mortality is too high; that the ultimate physiological effect is not known; that achlorhydria may lead to pernicious anæmia; that the essential cause of the ulcer is not being attacked; that according to Balfour [5] marginal ulcer not infrequently occurs even after this operation, and, finally, that gastro-enterostomy is a satisfactory method of surgical relief in the great majority of cases. The radicals claim that the operation is practical and of low mortality; that the physiological results are good; that not only hydrochloric acid, but the ulcer-bearing area is removed; that the possibility of malignancy is lessened; that anæmia does not occur; that marginal ulcers are very rare, and that gastro-enterostomy is a failure as a method of treating gastric ulcer and an inadequate method of treating duodenal ulcer.

It must be admitted that the majority of clinics in this country have published very optimistic reports on the results of gastro-enterostomy where these reports have been based in many cases on even more inadequate follow-up systems than those abroad. This is particularly true where cases have been followed for only one or two years. However, no matter which method of reasoning appeals to us, we all encounter problems, exclusive of malignancy, where some form of gastric resection has to be done of necessity, and if the results in these cases are studied they should be of value as coming from an entirely neutral source.

*Analysis of All Cases of Subtotal Gastrectomy 1923–1927 for Benign Gastric Ulcer*

Hospital—Bellevue; No. 1058. Occupation—machinist, thirty-eight years of age. Date and type of last operation—June 3, 1926; post-colic polya. Date and type of former operation—January 26, 1921; suture of perforated ulcer with gastro-enterostomy. Pre-operative X-ray findings—persistent duodenal ulcer; stoma normal; six hour residue.

Operative findings—persistent duodenal ulcer; inflamed stoma; attached to transcolon. Post-operative course—smooth; discharge on eighteenth day. Post-operative X-ray—October 22, 1924; partial gastrectomy; normal stoma; rapid emptying. Post-operative gastric analysis—November, 1928, total acidity 17; free hydrochloric acid 0; bile. Final follow-up—gaining weight; occasionally gas; no pain; health good; sticks to diet.

Hospital—Bellevue; No. 1928. Occupation—chauffeur, forty-one years of age. Date and type of last operation—February 10, 1927; anterocolic polya. Date and type of former operation—April 28, 1922; excision of duodenal ulcer; gastro-enterostomy. Pre-operative X-ray findings—February 1, 1927; duodenal ulcer—persistent; adhesions at stoma; stasis in proximal loop of jejunum. Operative findings—apparently healed duodenal ulcer; crater ulcer invading transcolon. Post-operative course—smooth; discharge on twenty-second day. Post-operative X-ray—October 30, 1928, stoma normal; rapid emptying. Pre-operative gastric analysis—January 15, 1922, total acidity 70; free hydrochloric acid 30; February 8, 1927, total acidity 30; free hydrochloric acid 12. Post-operative gastric analysis—November 11, 1928, could not get back test meal. Final follow-up—gaining weight; feels well; herniæ.

Hospital—Bellevue; No. 2230. Occupation—chauffeur, forty-two years of age. Date and type of last operation—October 31, 1924; Billroth No. 2. Date and type of former operation—April 20, 1922; excision of duodenal ulcer; gastro-enterostomy. Pre-operative X-ray findings—duodenal ulcer; tender stoma. Operative findings—recurrent duodenal ulcer; jejunal ulcer penetrating colon. Post-operative course—one severe vomiting attack; discharge twenty-fifth day; transfusion. Post-operative X-ray—April 28. 1926. hypersthenic; normal stoma; rapid emptying. Pre-operative gastric analysis—April 18, 1922, total acidity 80; free hydrochloric acid 30. Final follow-up—April 4, 1924, above weight; taxi driver; alcoholic; symptom free; July, 1928, symptom free.

Hospital—Bellevue; No. 3002. Occupation—laborer, fifty-three years of age. Date and type of last operation—January 26, 1923; Billroth No. 2. Date and type of former operation—none. Pre-operative X-ray findings—January 22, 1923; large perforating ulcer of lesser curvature, possibly malignant. Operative findings—massive penetrating lesser curvature ulcer. Post-operative course—discharge seventeenth day; transfusion; vomited twice post-operative. Post-operative X-ray—October 29, 1928, stoma normal in structure and function. Pre-operative gastric analysis—total acidity 45; free hydrochloric acid 25; guaiac lactic. Post-operative gastric analysis—November 25, 1928, total acidity 22; free hydrochloric acid 13. Final follow-up—slightly under weight; occasionally gas.

Hospital—Bellevue; No. 3514. Occupation—invalid, sixty-one years of age. Date and type of last operation—July 27, 1923; sleeve resection. Date and type of former operation—none. Pre-operative X-ray findings—ulcer of lesser curvature, possibly malignant. Operative findings—penetrating ulcer posterior wall of lesser curvature; base in pancreas. Post-operative course—pneumonia; transfusion. Post-operative X-ray—October 28, 1924, deformity pars media; tuberculosis both lungs. Final follow-up—died May 9, 1927, pulmonary tuberculosis.

Hospital—Bellevue; No. 3788. Occupation—barge captain, forty years of age. Date and type of last operation—June 1, 1926; post-colic polya. Date and type of former operation—December 7, 1923; gastro-enterostomy. May 25, 1925; post-colic polya with jejunojejunostomy. Pre-operative X-ray findings—recurrent jejunal ulcer. Operative findings—diffuse acute inflammation of entire stoma and ulcer lower angle. Post-operative course—very stormy; transfusion. Post-operative X-ray—October, 1928, fluoroscopy showed normal stoma. Pre-operative gastric analysis—December 4, 1923, total acidity 95; free hydrochloric acid 80; June 30, 1926, total acidity 65; free hydrochloric acid 25. Post-operative gastric analysis—December, 1928, no gastric residue after test meal. Final follow-up—December, 1928, working as barge captain; no complaints.

Hospital—Bellevue; No. 4270. Occupation—carpenter, fifty years of age. Date and type of operation—June 3, 1924; Billroth No. 2. Date and type of former opera-

tion—none. Pre-operative X-ray findings—penetrating ulcer, lesser curvature; pars media. Operative findings—large lesser curvature ulcer pars media; many large nodes. Post-operative course—temporary obstruction; re-open; no cause found—tube passed; afterward smooth. Post-operative X-ray—September 28, 1928, rapid emptying; stoma tender. Pre-operative gastric analysis—September 28, 1920, total acidity 60; free hydrochloric acid 40. Post-operative gastric analysis—November 11, 1928, total acidity 25; free hydrochloric acid 0. Final follow-up—symptom free; neurotic.

Hospital—Bellevue; No. 4485. Occupation—laborer, forty-two years of age. Date and type of last operation—October 10, 1924; sleeve resection. Date and type of former operation—none. Pre-operative X-ray findings—ulcer lesser curvature pars media. Operative findings—large lesser curvature, penetrating ulcer both walls, anterior and posterior. Post-operative course—infection of hypodermoclysis, otherwise smooth. Final follow-up—May 19, 1925, pain immediately after meals for fifteen minutes; lost.

Hospital—Bellevue; No. 4542. Occupation—chauffeur, thirty-six years of age. Date and type of last operation—November 7, 1924; anterocolic polya. Date and type of former operation—November 3, 1921; suture of acute perforated duodenal ulcer. Pre-operative X-ray findings—ulcer of first part of duodenum with adhesions. Operative findings— healed duodenal ulcer; large indurated ulcer posterior wall lesser curvature, near pylorus. Post-operative course—very smooth; discharge eighteenth day. Post-operative X-ray—October 30, 1928, normal stoma; slight delay in distal jejunum. Post-operative gastric analysis— November 4, 1928, total acidity 5; free hydrochloric acid 0. Final follow-up—ignores diet; works thirteen hours a day; underweight, but symptom free; excessive tobacco.

Hospital—Bellevue; No. 4664. Occupation—housewife, forty-eight years of age. Date and type of last operation—January 16, 1925; post-colic polya with partial closure of stomach. Date and type of former operation—none. Pre-operative X-ray findings— penetrating ulcer lesser curvature pars media; no retention. Operative findings—per-forated ulcer lesser curvature; found by exploring gastric lumen. Post-operative course— very smooth; discharge twenty-eighth day. Post-operative X-ray—April 14, 1925, nor-mal stoma. Post-operative gastric analysis—November 4, 1928, amount twenty-five cubic centimetres; total acidity 7; free hydrochloric acid 0. Final follow-up—has some distress after meals.

Hospital—Bellevue; No. 4974. Occupation—laborer, forty-nine years of age. Date and type of last operation—May 21, 1925; post-colic polya. Date and type of former operation—none. Pre-operative X-ray findings—gastric ulcer. Operative findings— double ulcer lesser curvature near pylorus with craters. Post-operative course—smooth; discharge twentieth day. Pre-operative gastric analysis—May 16, 1925, total acidity 30; free hydrochloric acid 20. Final follow-up—April 20, 1927, ignores diet, alcoholic; symptom free.

Hospital—Bellevue; No. 5355. Occupation—clerk, twenty-four years of age. Date and type of last operation—November 6, 1925; Billroth No. 1. Date and type of former operation—none. Pre-operative X-ray findings—ulcer of first part of duodenum. Oper-ative findings—circumferential ulcer just beyond pylorus. Post-operative course—dis-charge seventeenth day. Post-operative X-ray—June 5, 1928, irregular first part of duodenum; no ulcer. Post-operative gastric analysis—October 18, 1928, total acidity 24; free hydrochloric acid 14. Final follow-up—October 18, 1928, now symptom free; has had occasional after meals' distress; neurotic.

Hospital—St. Vincent's; J. B. Occupation—Waiter, forty-six years of age. Date and type of last operation—November 27, 1925; anterocolic polya. Date and type of former operation—none. Pre-operative X-ray findings—carcinoma of pylorus. Operative findings—very large callous penetrating ulcer of pylorus; accessory pancreatic duct divided. Post-operative course—pancreatic fistula; death in four weeks from progres-sive malnutrition. Final follow-up—died twenty-five days post-operative; pancreatic fistula.

Hospital—St. Vincent's; M. H. Occupation—housewife, fifty-two years of age.

Date and type of last operation—December 6, 1925; anterocolic polya. Date and type of former operation—none. Pre-operative X-ray findings—carcinoma of pylorus with obstruction. Operative findings—apparently a localized linitis plastica of pylorus portion. Post-operative course—very smooth. Post-operative gastric analysis—October, 1928, only a few cubic centimetres returned on lavage in one-half hour after meal. Final follow-up—October, 1928, gaining weight; is eating everything; moderately alcoholic.

Hospital—Bellevue; No. 6432. Occupation—laborer, forty-one years of age. Date and type of last operation—May 24, 1927; anterocolic polya. Date and type of former operation—May, 1918; suture of acute perforated gastric ulcer. Pre-operative X-ray findings—ulcer lesser curvature about junction of para pylorus and para media. Operative findings—lesser curvature para media, penetrating ulcer covered with omentum and liver; many adhesions from old peritonitis. Post-operative course—(illustration) ulcer; wound infection; discharge thirty-third day. Pre-operative gastric analysis—total acidity 70; free hydrochloric acid 60. Final follow-up—October, 1928, ignores diet; alcoholic; no gastro-intestinal complaints.

Hospital—Bellevue; No. 6666. Occupation—fishmonger, thirty-nine years of age. Date and type of last operation—November 4, 1927; post-colic polya. Date and type of former operation—none. Pre-operative X-ray findings—ulcer of lesser curvature. Operative findings—posterior wall para media penetrating ulcer, deep crater. Post-operative course—thirty-six hours shock, then very smooth; discharge twentieth day. Post-operative X-ray—October, 1928, mobility excellent; rapid evacuation; no deformity of stoma or jejunum. Pre-operative gastric analysis—total acidity 78; free hydrochloric acid 51. Post-operative gastric analysis—November, 1928, total acidity 15; free hydrochloric acid 0; bile. Final follow-up—November, 1928, occasionally gas and slight after meals' distress two or three times a week for a time; now O. K.

Hospital—Bellevue; No. 2911. Occupation—carpenter, thirty-three years of age. Date and type of last operation—October 27, 1926; anterocolic polya. Date and type of former operation—December 28, 1922; cholecystectomy; appendicectomy, June 22, 1923; excision and cauterization of gastric ulcer; gastro-enterostomy. Pre-operative X-ray findings—October 22, 1926; penetrating ulcer upper part of lesser curvature; gastro-enterostomy; stoma patent and tender. Operative findings—lesser curvature ulcer; healed pyloric ulcer. Post-operative course—post-operative pneumonia; recovery. Post-operative X-ray—no irregularity at site of anastomosis; stoma function excellent; no six hour residue. Pre-operative gastric analysis—June 13, 1923; total acidity 72; free hydrochloric acid 45; combined hydrochloric acid 12. Final follow-up—no complaints; symptom free; January 4, 1927, July 10, 1928, December 20, 1928.

With this in view I have made a study of all my cases of subtotal gastrectomy performed for a benign ulcerated condition. The series covers a period of eight years and includes seventeen cases, fifteen of which were on the First Surgical Division of Bellevue Hospital and two on the First Surgical Division of St. Vincent's Hospital. In seven cases there had been a previous operation on the stomach and in one case there had been two previous operations. This was the only case in which a marginal ulcer occurred after subtotal gastrectomy. Four had had a previous gastro-enterostomy for gastric ulcer; one had had a previous gastro-enterostomy for chronic ulcer; one had had a previous gastro-enterostomy following closure of acute perforated duodenal ulcer; two had had simple closures of acute perforations, one of duodenal and one of gastric ulcer.

Billroth No. 1 was performed only once and hardly forms the basis of an opinion. Von Haberer and Finney have had their best results with this

operation. The Billroth No. 2 operation was done three times. Objections to this operation are that it requires more time and that the stoma is not as well placed physiologically as in other methods. Sleeve resection was done twice and in one instance gastric symptoms persisted after operation. Retro-colic polya was done five times. It seems to me less satisfactory than the anterocolic polya. The opening in the posterior mesocolon may constrict the stoma or jejunum, and if this is provided for by a jejunojejunostomy we lose the benefit of the duodenal contents in alkalinization of the gastrojeju-nal stoma.

The anterior polya was done six times and I regard it as the operation of choice for the average surgeon. The theoretical objection has been raised that the jejunum passing in front of the transverse colon may constrict it, but after the pyloric part of the stomach has been re-moved with the corre-sponding portion of the gastrocolic omentum the colon falls posteriorly, so that the jejunum can be brought up to the gastric stoma without difficulty. After division of the duo-denum and ligation of the greater and lesser omental attachments to the stom-ach, the jejunum can be sutured to the posterior wall of the stomach with
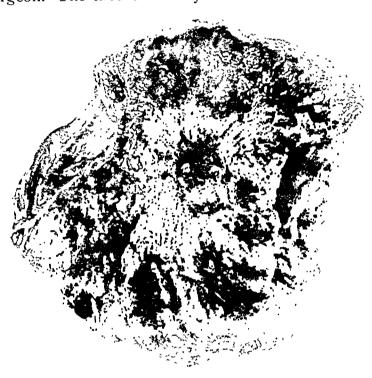


Fig. 1.—Photograph of gastric ulcer removed by sleeve resection.

seromuscular stitches proximal to the line of division before the ulcer-bearing area is removed. This makes the anastomosis much easier and allows a firm approximation at the lesser curvature where difficulty is so often encountered. I do not know who first advocated this procedure, but it was recommended to me by Doctor McCreery.

The pre-operative X-rays throughout the series were remarkably accurate, even to the exact localization of a jejunal ulcer in one case.

*Operative Findings.*—The lesions found were either primary or secondary. The primary lesions were mainly large crater ulcers of the lesser curvature, of which eight were situated in the pars media, two of them having their bases in the pancreas. There was one instance of what seemed to be a linitis plastica of the pyloric portion of the stomach causing obstruction. There were two instances of double ulcer, one on each side of the pylorus. In all of these penetrating ulcers there was a great deal of surrounding indu-ration and infiltration extending into the omentum or pancreas. There

were seven cases that had had previous operation, five having had a gastro-enterostomy, and two, simple suture of acute perforation. Of the five cases that had had gastro-enterostomy, four showed jejunal ulceration and in three of the four the ulcer was the penetrating type and attached to the posterior wall of the transverse colon in what was obviously an early stage of a jejunocolic fistula. The fourth case of jejunal ulceration had occurred at the stoma of a previous post-colic polya operation. It is not uncommon to find multiple ulcers in these recurrent lesions, and one is lead to believe that there is an ulcer-forming type in which a subtotal gastrectomy is particularly indicated, but it is hard to see how that can be recognized at the time of the primary lesion. The dense adhesions found in these secondary operations add greatly to the difficulty and length of time, and this feature is a strong argument in favor of primary resection.

The jejunum involved in the gastro-enterostomy should be resected at once and the lumen restored by an end-to-end anastomosis, the distal portion being used for the anterocolic polya. The Roux method is unsound and led to recurrence in the one instance where it was used. A median epigastric incision being used more than once is prone to herniation.

It is my belief that speed is quite essential in these operations and that the danger from soiling is too slight to justify the time



FIG. 2.—Gastric ulcer. Polya type of resection. Good result.

consumed in elaborate technic. We know that the peritoneum can successfully handle soiling from gastric contents for several hours following perforation without the necessity of drainage after closure. There was no instance in this series of post-operative intraperitoneal infection.

*Post-operative Course.*—Ether anæsthesia was used throughout, and there was always some degree of post-operative shock, varying from slight to severe. In four cases it was necessary to give a tranfusion of from 500 to 1000 cubic centimetres. After two of the Billroth No. 2 operations persistent vomiting occurred and this, I think, was due to transient failure on

FIG. 3.—Gastric ulcer resected by subtotal gastrectomy. Polya method. Good result.

Fig. 4.—Peritoneal aspect of preceding specimen.

the part of the stomach to use the new stoma. In one instance it was so persistent that obstruction was feared and the wound was re-opened on the fifth day. No obstruction was found, but as a precaution a stomach tube was passed and manipulated through the stoma before closing the abdomen. This procedure was followed by a smooth convalescence. No contraindication for gastric lavage was recognized, hæmorrhage being regarded as an indication. Returns from lavage invariably showed old blood and, I believe, as a rule, there is considerable post-operative oozing, in spite of the great care observed in hemastasis at the time of operation. Following the first twenty-four to thirty-six hours the convalescence is very uneventful, but during this first period careful nursing is essential.

*Post-operative X-ray.*—A check up of X-rays at varying intervals after operation was obtained in twelve out of fifteen living cases. A notable fact in the polya operation was the position of the gastric stump and the gastro-jejunal stoma, the stomach being absolutely vertical in position and well over to the left side. In all of the cases there was a very rapid emptying time. The Billroth No. 2 operation showed the persistence of a small pocket beyond the anastomosis.

*Gastric Analysis.*—The pre-operative gastric analyses were not always obtainable, but the recurrent type in general showed a high acidity. In ten of the fifteen surviving cases recent gastric analyses were obtained, varying from six months to several years post-operative. The Ewald test meal of a roll and a glass of water was given and expressed one-half hour later. In three cases the stomach was apparently empty and no contents could be expressed. Two of these had had an anterocolic polya and one a post-colic polya. In the other seven instances there was either a diminution of or a complete absence of hydrochloric acid. However, although the Ewald test meal is the one used by the von Haberer's clinic, it seems to me we should have some more exact method of determining the physiology of the stomach after subtotal gastrectomy.

*Final Results.*—Of the seventeen cases comprising this report, fifteen are living and at work. One was last seen about a year after a sleeve resection and has since failed to report. He was then complaining of pain about fifteen minutes after meals. Two others have had occasional attacks of epigastric distress and gas after meals, possibly due to decreased size of the stomach. One has had gastric symptoms which has occurred only after the onset of a tender gall-bladder. The others are entirely free from any complaint and only one has failed to gain weight.

Of the two deaths, one died four years after a sleeve resection from pulmonary tuberculosis, and previous to this had had no post-operative symptoms referable to the gastro-intestinal tract. There was one patient who died as the result of a pancreatic fistula following operation.

### HISTORY OF CASE OF OPERATIVE DEATH

At operation the pylorus and first portion of the duodenum were involved in a large indurated mass enfolding the gall-bladder. On separating this from the gall-bladder there

was found an old perforation about one centimetre in diameter leading into the pyloric end of the stomach. An anterocolic polya operation was performed.

In turning in the proximal end of the divided duodenum under purse-string sutures a very small, white band on the mesial side was divided. Being rather suspicious of this structure, it was probed and found to have a lumen which extended down the body of the pancreas. The common duct was then investigated and found to pass down through the head of the pancreas and into the duodenum, well beyond the area of resection. It was taken for granted that the duct of Wirsung accompanied the common duct into the papilla of Vater, and that the small-sized band was the accessory duct of Santorini entering the duodenum at a very high level. It was firmly ligated with chromic catgut, as there was no possibility of implanting it into the duodenum because of its minute size and because of its position.

The patient made a good recovery from operation, but forty hours later a discharge of clear, syrupy fluid appeared from the upper part of the wound. It was colorless, and a specimen which was sent to the laboratory was diagnosed as pancreatic juice. It became very profuse in amount.

Temperature and pulse remained normal and emaciation and weakness developed to an alarming degree. After two weeks the fluid tended to decrease in amount. Emaciation and weakness steadily increased and he died of malnutrition on the twenty-ninth day.

Examination of the fæces showed no free fat. Blood chemistry showed blood sugar, creatinine and urea normal. Non-protein nitrogen high.

I do not know of any procedure that could have been attempted, post-operatively, to save this patient. The accessory duct, which was divided, occurs in this high position, according to the Dissection Room Records, only once in a hundred and fifty times, and it is exceedingly rare to have it the main pancreatic duct.

### CONCLUSIONS

1. After recurrent ulcers of the stomach or duodenum and after marginal or secondary jejunal ulcers, the polya operation offers a reasonably safe and satisfactory method of relief from chronic invalidism.

2. As far as can be determined by X-ray and by the Ewald test meal, subtotal gastrectomy establishes and maintains a very rapid emptying of the stomach with marked diminution or disappearance of free hydrochloric acid in proportion to the amount of stomach removed.

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# URETERO-ENTEROVENTRAL FISTULA*

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FROM THE MAYO CLINIC

To HAVE either a urinary or a fæcal fistula is unfortunate, but to have a combination of both, secondary to an infected ectopic kidney which necessitates operation, is almost unique.

Ectopic kidneys are not only relatively uncommon, but when they become diseased are difficult of removal. The condition is caused by a r r e s t of the upward course of the renal anlage, from its original position in the fœtal pelvis to its normal resting place in the back. Usually these kidneys become arrested just at the brim of the p e l v i s or a little above. The true variety derives its vascularization usually from the common iliac vessels, whereas the acquired type, which is occasionally met with, is supplied by an artery which develops from the upper abdominal aorta. Müller's duct does not normally d e v e l o p until the primitive kidney has reached its final level in



FIG. 1.—Injection, by syringe, of brominated lard oil through the fistulous tract demonstrated, under Röntgen-ray, the connection between the patent ureter and the ileum.

the loin; hence it is not difficult to imagine or to find accompanying malformations of the intestinal tract or generative organs arising from Müller's duct in the individual who has a true ectopic kidney. Although such malformations may be single or multiple, they probably are more often absent than not, and when present, symptoms, definite or masked, accompany them in proportion as their functions are disturbed. Not infrequently, symptoms

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FIG. 3.—Incision around umbilicus and the fistulous tract which is to the left and immediately below it. A block of the abdominal wall down to the muscle is excised, removing not only the umbilicus and the old scar, but beginning dissection of the tract.
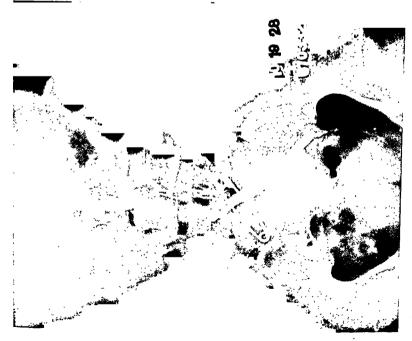


FIG. 2.—Connection between the patent ureter and fistulous tract. The tube had been indwelling for eleven months.

secondary to developmental anomalies of any of the human systems develop slowly and evidence themselves in the middle or latter decades of life. Ectopic kidney is found as a tumefaction in the lower portion of the abdomen, more often, for anatomic reasons, occurring on the left side than on the right. Its distribution as to sex is about equal. The suprarenal glands, because of their independent development, more often than not are found in their normal positions in the back, regardless of the situation of the kidneys.

The case which we present for record is interesting from several stand-



FIG. 4.—The abdomen is opened widely and the tract from the abdominal wall down to the renal pocket is shown. The dense adhesion between the small bowel and the kidney hits a fistulous opening demonstrable by Rontgen-rays.

points. The patient had been operated on elsewhere. An ectopic kidney had been found on the left side and had been partially removed, but with subsequent development of a ventral urinary and fæcal fistula. The successful removal of the fistulous tract, as well as of the remainder of the kidney and ureter, with closure of the opening in the intestine, makes the case seem worth while to report.

The patient came to the clinic in October, 1928, and gave the following history: November 16, 1927, while at work as a cook, he suddenly had been taken with severe pain in the left lower quadrant of the abdomen. The pain lasted two and a half hours and was "shooting" in character. He became weak, fainted, and was put to bed. The following day he returned to work. The next day he discovered a "lump" to the left and below the umbilicus. It became larger until November 20, when he went to the hospital where he was given massage and hot packs. Trouble with the bowels was not present at that time. The following is a report from his surgeon:

"This man entered the hospital with a mass over the pubic region. It was not relieved by catheterization. There was no increase in temperature or in pulse. The bladder was completely emptied. Catheterization of the ureter was unsuccessful on the left side. An operation was decided on.

"On opening the abdomen, he was found to have a pelvic kidney, with a pedicle about one-half inch long and what was apparently an enormously dilated pelvis of the ureter, lying in front of the promontory and a little to the right side, closely adherent to the sacropromontory and lower lumbar vertebra. This contained about a pint of pus. The lining was spongy and bled profusely when touched. On account of the bleeding the pus was removed, the cavity packed and left for three weeks. At the end of three



Fig 5 —Displacement of the sigmoid to the right, its mesenteric attachment being well over to the right side of the pelvis The ureter and remainder of the kidney, which contains several ounces of pus, are shown, as well as the tract which communicates with a coil of small bowel. The remainder of the kidney is tightly adherent to, and derives its blood supply from, the common iliac vessel.

weeks, the cavity was reopened and all of the sac was removed except that which was attached posteriorly. There was no ureter, on opening, to be found. The kidney was also removed. The wound was closed with a drain left in. This wound remained without healing and with a continuous discharge.

"I was not here for several months and on my return investigated the wound. I found it extended down into the pelvic cavity with a very soft, or no, wall in the pelvis. The discharge, apparently, was urine, as I put argyrol in the bladder and this drained into the wound. On this account I wished to make further investigation which was refused here and the patient decided to go to your place for treatment."

The rubber tube drain which had been inserted November 22, 1927, and had been removed and reinserted January 21, 1928, was still intact when the patient arrived at the clinic in October, 1928. The patient had not been well since the nephrectomy; pus had drained constantly from the wound. In July, 1928, considerable watery drainage had been present; early in September, urine had begun to drain and had continued to drain until three and a half weeks before admission to the clinic. During September faecal material also had drained from the sinus, off and on.

General examination revealed a rather nervous pale man, five feet nine inches tall, weighing 126 pounds (a loss of twenty-four pounds). Except for the foul, draining sinus, with a rubber tube in a low median-line scar, examination was negative. Masses



Fig 6.—The operation is complete here, with the exception of removal of the tract and ureter and the reperitonization, as far as possible, of the raw surface at the brim of the pelvis The sutuie line shows where the opening in the small bowel was closed A ligature is shown on the ureter at its entrance into the bladder.

could not be palpated and the lower portion of the abdomen was only mildly tender. Urinalysis was negative. Examination of the blood revealed haemoglobin to be 76 per cent.; erythrocytes numbered 4,960,000 and leucocytes 8,500. The Wassermann reaction of the blood was negative. The blood urea was twenty-four milligrams in each one hundred cubic centimetres. Röntgen-ray examination of the colon, performed by barium enema, disclosed transposition to the right of the sigmoid and descending colon. A ureterocolic fistula was not visualized. The same report of Röntgen-ray examination was given after a barium meal had been administered by mouth (stasis ray). Röntgen-ray examination after injection by syringe of brominated lard into the fistulous tract revealed patency between the ileum and ureter. (Figs. 1 and 2.) The patient was operated on November 5, 1928.

At operation there was a drainage tract extending from just below the umbilicus into a cavity which communicated with the left ureter. It was evidently from the old

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renal cavity. The wall of the cavity was tightly adherent to the common iliac vessels on the left side. About 100 cubic centimetres of thick, creamy pus poured out when an opening was made into the remnant of the renal pelvis. A small opening which connected the cavity with the ileum was found and was closed. The ureter was traced down, was tied near the bladder with silk and was dropped back into the abdominal cavity. The dissection was carried out mostly in the mesentery of the sigmoid. The sigmoid, as found on Röntgen-ray examination, lay on the right side. (Figs. 3 to 6.) The pathologist's report of a section of the tract was: "Inflammatory sinus tract with attached inflammatory ureter."

The patient was dismissed twenty-seven days after the operation with the wound healed. He weighed 121 pounds. The convalescence and the results were very satisfactory.

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# EXTENSIVE RESECTIONS OF THE SMALL INTESTINE *

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The term "Extensive" as applied to resections of the small intestine has arbitrarily been accepted to embrace only those lengths, measuring 200 centimetres (6 ft. 7 in.) or more. This measurement is accepted on the basis of clinical records, which prove that resections beyond 200 centimetres may give rise to various metabolic disturbances.

Various authors give the length of the small intestine between fifteen feet, six inches and thirty-one feet, ten inches. The summary of opinion would place the average length at twenty-two and one-half feet. Brenizer found that the small intestine not only varied, within wide limits of length in the dog, but also in man and varied with the height and weight of the individual, usually the larger the individual, that is the taller and fatter, the longer the intestine. Beneke states that for every 100 centimetres (3 ft. 3½ in.) of body length there is 387.5 centimetres (12 ft. 9 in.) of small intestine, and Flint claims that there is a definite ratio between the size of the individual and the epithelial surface of the intestine.

In the work of Evans and Brenizer it was also observed that the intestine measured *in situ*, that is, attached to the mesentery, was much shorter than when measured detached from the mesentery; that a variable of several feet might be gained through stretching the length. Due to the natural variability in length, that due to detachment and stretching, they made their reports more accurately in percentage.

Again, in children, the intestine, though relatively to size longer, is actually shorter than in adults, allowing, length for length, a shorter resection to equal or excel the percentage resected in the adult.

The important question is not so much the extent removed as that left behind, either measured directly, which is frequently difficult or impossible, or estimated by that removed.

## RECORDED CASES

Up to June, 1923, Pirie Watson, using the tables of all authors to date, collected seventy-three cases, including his own, in a most exhausting search of the literature.

Doerflor reports a case six and one-quarter years after removal of 560 centimetres (18 ft. 8 in.) of the small intestine, leaving only twelve centimetres (4 and 4/5 in.) of jejunum and twenty centimetres (8 in.) of terminal ileum, and claims the patient to be in good health, no complaint, takes regular meals, has two stools a day, gets up at 5 A.M. and does his whole work at the age of fifty-eight. He raises the question: "Is the small intestine essential for life?"

Sohn resected the entire jejunum and part of the ileum, 275 centimetres (9 ft.

2 in.), and reports the case again four and one-half years later as subjectively well and strong, but further examinations of metabolism refused by patient.

SARNOFF resected fifteen feet of the small intestine and did a hysterectomy, recovering the patient after a stormy course and fæcal fistula. The patient presented the typical symptoms credited to such extensive resection, namely, thirst, hunger, diarrhœa, loss of weight and sensitive intestines, all of which occurred during the first few weeks of her illness. The patient, six months later, is in good condition; appetite undiminished, has two bowel movements daily instead of being constipated as before operation.

HOFMANN reported two cases, 385 centimetres (12 ft. 6 in.) and 300 centimetres (10 ft.), after five and one-quarter and four years respectively. The former case, a woman, tolerated a resection of twelve feet, six inches of small intestine and cæcum, lived three years complaining of dyspepsia; on finding two callous gastric ulcers, the size of a small apple, a posterior gastro-enterostomy was done with recovery; experienced two and one-quarter more years of relative comfort, except for a ravenous appetite and diarrhœa, and died of basilar meningitis (tuberculous). Hofmann failed to find any histological difference between the intestine removed and preserved five and one-quarter years previously and that recovered at autopsy. The latter case, a man, bore a resection of ten feet of the small intestine, continued to complain with symptoms typical of ulcer of the stomach, experienced, likewise, a gastro-enterostomy for ulcer of the stomach and is living after four years and doing fairly well on a restricted diet. Hofmann explains the ulcers, likely due to a retrograde infected embolus, slipped at the time of the resection operations, and quotes Eiselberg, that ulcers of the stomach and duodenum are not infrequent after massive procedures in the abdomen.

JACKSON resected 142 centimetres (4 ft. 8 in.) and left twelve inches of the ileum in a child two years old. This resection he calculated to be two-fifths of the entire small intestine and exceeding the arbitrary extensive resection in the average adult. For the first year the bowel movements were almost continuous, but gradually improved for five years and after seven years still has some "stomach trouble" and diarrhœa on account of a ravenous appetite and indiscretions in diet.

PALMER'S case, 327 centimetres (10 ft. 1 in.) resected and about 80–90 centimetres (2 ft. 6 in.) left behind was operated on for so-called "knot formation". This case made an excellent recovery and was used by Tuomikoski for his experiments in metabolism, where he found fats and proteins are poorly utilized but that carbohydrates are well borne. This author stressed the importance of a well-developed colon favoring his nutritional results.

SCHUGT reports, on April 11, 1925, a case of perforation of the uterus with gross injury and extensive resection of a case operated by Professor Dietrich March 30, 1924, when, according to Beneke's estimations, 580 centimetres (19 ft. 4 in.) of the small intestine was removed, likely 95 per cent. of the whole small intestine. By January 26, 1925, she had gained five and one-half pounds over her usual weight and complained only of gas after potatoes and vegetables, and of some weakness.

FLOSDORF resected 200 centimetres (6 ft. 7 in.) of small intestine and reports the case after three years. During the last year there are marked digestive disturbances, loss of weight, and patient is a chronic invalid, getting worse and not expected to live.

BRENIZER.—Mr. W. M., age twenty-one years, entered the hospital November 22, 1927, abdomen distended, painful, vomiting, fæcal fistula. He was operated on in another town for puss appendix in December, 1926, and drained. Remained in the hospital for nineteen days and drained for a month and half after leaving the hospital, wound finally healing March 16, 1927, vomited, and had difficulty getting bowels to move. September 1, 1927, reentered same hospital, vomiting and no bowel movements. Was operated on for the second time and loop of bowel opened. Shortly after this operation, wound split open and another loop of bowel came out of wound. Attempt to replace the loop was futile and it was cut off. Remained in hospital forty-two days. Four days

after leaving, the flow from the intestine stopped and he returned to hospital, when a forceps was put into the wound and spread, on October 16, 1927. This opening continued to drain fæcal matter irregularly until November 21, when it stopped again, and since then he has been vomiting and having no bowel movement. Has steadily lost weight, from 168 down to 102 pounds; is pale and weak.

Temperature, 99-4; pulse, 110; respiration, 20; blood pressure, 95/60.

Abdomen: Distended, firm, tympanitic. McBurney scar; right rectus scar; two fistulous openings, from one pus can be pressed from hard mass on left side below navel. Small amount of fæcal matter from other.

Operation, November 22, 1927. Excision of old right rectus scar with fistulæ, liberation of massive adhesions to abdominal wall and between intestinal loops; considerable pus between loops on lower left side. Intestine severed in several places. Due to several separate segments of severed intestine shredding on liberating, nine and a half feet of ileum was resected, leaving about six feet of ileum and jejunum behind. A lateral anastomosis was done between the ileum and much damaged cæcum. Patient, already weak, was very much collapsed from rough handling, and blood ooze, was given 500 cubic centimetres of blood on the table. Picked up markedly.

The after course was surprisingly uneventful. Proctoclysis and liquids for first four days, then semi-soft diet for six days and soft diet for remainder of three weeks in the hospital. The wound scarcely drained at all for five days, the drains were removed and wound healed. At first there were five or six stools a day and two or three stools a day for six weeks. Patient returned for examination in three months, having eaten, after six weeks, practically a full diet. He had gained from 102 to 172 pounds, felt well, and had three stools a day. Urine was negative.

X-ray: Stomach emptied in one and one-half hours; small intestine visible in streaks; colon filled in three hours.

Patient returned November 16, 1928, looking well, feeling strong, doing his work and eating what he wants; is very hungry for his meals; has two stools a day; weighs 168 pounds, his regular weight.

X-ray: Examination one hour after the ingestion of barium meal showed about an 80 per cent. residual in the stomach and the head of the barium column in the ileum. The two hour examination showed about a 40 per cent. residual in the stomach, the barium to be scattered throughout a few loops of small intestine. The loops of the small intestine well filled are few. The head of the barium column is in the ascending colon near the hepatic flexure, the colon distal to this being well filled. The enterostomy stoma is low in the pelvis, consequently cannot be manipulated. The five hour examination showed the stomach to be empty and the barium to be scattered from terminal ileum well down into the descending colon.

Fæces: Normal, no blood, no mucus, no excess of fat and nitrogen. White blood cells 11,000; red blood cells 5,500,000; hæmoglobin (Sahli) 95 per cent.

Including my own case the total number of cases published to date, where the resection of the small intestine exceeds 200 centimetres (6 ft. 7 in.) is eighty-three, with seventy-one operative recoveries. The natural tendency has been to report only successful cases where the recovery lasted for several months or years. This accounts for the surprisingly low death rate in the published cases—14.3 per cent. There have been recently deaths reported after two to five and one-half years. The percentage of recovery from operation equals 85.7 per cent. and the percentage of good functional recoveries is 65.5 per cent.

The series includes cases of small intestine resections ranging from that of Flosdorf, six feet seven inches, with death from digestive disturbances

and inanition in three years; that of Brenner, seventeen feet nine inches, with death from marasmus in two and a half years; up to that of Schugt, nineteen feet four inches, and that of Doerflor, eighteen feet eight inches, in excellent condition after one year and six and one-quarter years respectively.

We must conclude from the clinical evidence drawn from these cases that the minimum extreme resection may fail in time and the maximum offer excellent results and that there are always possibilities for good or bad between the two extremes.

The ages between eleven months and sixty-five years have been reported but most of the cases occurred between twenty to forty years; and the sex has been fairly equally distributed in these cases where it was mentioned.

Extreme resection of the small intestine is almost always an emergency procedure, in a bad risk case, where the surgeon is caught between the two alternatives of resection or letting the patient die. The morbid condition is mentioned in sixty-four out of the eighty-three cases reported:

Twenty-one cases were strangulated herniæ: 7, variety not stated; 7, inguinal; 2, femoral; 3, umbilical; 2, ventral.

Nine cases were for strangulation from omental and other bands and adhesions.

Eleven cases were for trauma: 3, rupture of mesentery and intestine; 6, rupture of uterus with protrusion of intestine; 2, gangrene after intestinal prolapse through a punctured wound.

Seven cases were for abdominal tumors: 5 of the mesentery, fibroma, myxofibroma, myxosarcoma, sarcoma; 1, ovarian, 1, carcinoma of cæcum, with metastases in mesocolon and mesentery.

Four cases were for multiple strictures (tuberculous).

Three cases for mesenteric thrombosis.

Four cases for volvulus.

Two cases for intussusception.

One case, so-called "knot formation".

One case of gangrene of bowel following appendicitis.

The method of restoring the continuity of the bowel is recorded in forty-four of the eighty-three cases. About 75 per cent. were a lateral anastomosis and 25 per cent. end-to-end (a larger opening and greater security has been sought).

In eight of the cases between 1901 and 1909 the Murphy button was used with success, but the unsuccessful cases, where it was used, are not reported. The part of the intestine resected is mentioned in thirty-four out of the eighty-three cases, the jejunum was included in five of these cases. From a physiological standpoint, resection of the jejunum should cause more digestive disturbances than resection of the ileum, but this fact has not been proven either from the recorded cases, nor the contradictory experiments on animals.

The average of good functional recoveries is 65.5 per cent. (thirty-seven out of fifty-seven cases). Diarrhœa is the most disturbing disorder of metabolism, coupled with a ravenous appetite and therefore a morbid tendency on the part of the patient to break the diet. Almost all authors are agreed that

foodstuffs are most disturbing in the following order: Fats, proteins, bulk of cellulose material, and carbohydrates. The painstaking experiments of Tuomikoski on Palmer's case (327 cm. resected, 80-90 cm. of jejunum left behind—75 per cent. to 80 per cent. removed) would confirm and establish the fact that fats and proteins are poorly utilized, while carbohydrates are well borne. This author, as well as several others, have been impressed with the idea that a well-developed colon favored their nutritional results. This is undoubtedly true, the longer, the less irritable the colon, the longer the delay in the colon, favoring a longer continued digestion of material squirted into the colon and its more complete absorption. Where X-ray reports after resection are recorded, as in my own case, the emptying of stomach and small intestine, and consequently the colon, is at first very rapid, followed in the course of time, a year or more, by delay in emptying of the stomach and remaining small intestine, as well as delay in the colon. In my own case two months after operation the stomach was completely empty in two hours, the coils of the small intestine could scarcely be pictured, but, after one year, the stomach was not completely emptied up to five hours and the intestinal coils were easily pictured with accumulation in the terminal ileum.

The reports on the urine have been recorded only in a few cases, using an excess of indican and ethereal sulphates to indicate increase in intestinal putrefaction. An excess was commonly found in dogs subjected to extreme resections. In all reports except five the urine has been reported normal. There have been no satisfactory reports on the blood picture and blood chemistry, nor on the metabolic rate.

The combined work of experiments on dogs initiated by Senn in 1892, Trzebicki in 1894, Monari in 1896, Diliberti-Herbin in 1904, culminated in the work of Evans and Brenizer in 1907, and Flint in 1912. Evans and Brenizer, in 1907, resected one-third to one-half of the combined jejunum and ileum on four animals which recovered. They noted a compensatory hypertrophy localized to the anastomosis. In two animals resections of 76 per cent. and 85 per cent. of the small intestine were followed by recovery, but in three animals resections of 86 to 92 per cent. resulted in death from inanition. In these animals the limit had been exceeded beyond which compensation could be established, and as no hypertrophy was noted at their autopsies, Evans and Brenizer concluded that in animals one-third to one-half of the combined jejunum and ileum can be resected with safety, but that beyond this limit compensation may fail to be established and death from inanition results. This limit of resection with safety corresponds with the arbitrary limit accepted in man, that of 2 metres (6 ft. 7 in.).

Flint in 1912 carried his work on beyond that of Evans and Brenizer, but arrived at about the same limit of resection. He concluded: "Dogs from which about 80 per cent. of the combined ileum and jejunum have been removed or short circuited may live indefinitely after the operation. The first effects of the operation give a profuse diarrhœa and loss of weight, from both of which the animal slowly recovers. At the same time the resec-

tion of a smaller amount, $c.g.$, 65 per cent. of the entire intestine may lead, notwithstanding a ravenous appetite and an unlimited diet, to changes which prevent the dog from recovering its well nourished condition. In these animals the nutrition may be apparently normal, but they are nevertheless so sensitive to dietetic disturbances that a diet or conditions of any severity may introduce a fatal marasmus or enteritis. Flint found that young, growing animals did not stand the operation as well as older dogs. Still, his case of an infant, eleven months old, in whom a resection of 100 centimetres, more than one-third of the entire intestine at this age and equal to the arbitrary limit of 2 metres in the adult, was done made an excellent recovery, although, at first, there were severe digestive disturbances.

Flint's investigations into the metabolism of these animals showed an excess of nitrogen and fat in the fæces as a direct result of diminution, of the absorbing surface of the gut. Profuse diarrhœa invariably occurred after the operation and the animals lost weight, being forced to consume the nitrogen and fat of their own tissues. Gradually, however, the excessive excretion of nitrogen and fats diminished through a restoration of the power of absorption in the remaining gut and the animals return to normal nutrition. They remain, however, susceptible to changes in diet, so that diets rich in proteins, fats or indigestible substances may again produce diarrhœa with excess of nitrogen and fat in the fæces.

Finally, the most important question: Does functional recovery depend on compensatory hypertrophy of the remaining small intestine? According to Flint, there is an increase in the transverse dimensions of the bowel, no increase in the number of villi, but an increase in their size, which equals 400 per cent. increase of surface. The crypts were enlarged in proportion to the enlargement of the villi. The epithelial cells of the hypertrophied villi were increased in size and the goblet cells were numerous. He found this anatomical compensation present and complete, or partial, or absent, with a corresponding recovery or not of the animal. Brenizer and Evans noted a compensatory hypertrophy localized to the anastomosis alone.

The clinical course in man, in many cases, corresponds with these anatomical findings of Flint, although no compensatory hypertrophy has been reported in humans as yet. On the other hand, as already referred to, Hofmann failed to find any histological difference between intestine removed five and one-quarter years previously and that recovered at autopsy. Was this a case where compensatory hypertrophy was incomplete and finally failed?

### CONCLUSIONS

1. The arbitrary limit of assured safety, two metres (6 ft. 7 in.), applied to resections of the small intestine, is embraced in the term extensive.

2. Resections up to and beyond the arbitrary limit have become necessary as a life-saving measure and have yielded 85.7 per cent. recoveries from operation and 65.5 per cent. good functional results.

3. Functional recoveries in man, as in dogs, are likely dependent upon compensatory hypertrophy.

4. Metabolic studies both in animals and man establish a diet rich in carbohydrates, less of proteins, but poor in fats.

In the preparation of this paper, though I have read all references in their original, I have, of a necessity, drawn abundantly on the paper of Pirie Watson, a veritable statistical compilation up to that date, June, 1923, and wish to credit him and thank him for any material or expression I may have borrowed from him.

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# THE DIAGNOSIS OF PRIMARY NEOPLASMS OF THE RENAL PELVIS *

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CARCINOMATA comprise approximately 5 per cent. of all renal neoplasms, and while the derivation of extensive malignant new growths of epithelial origin may be impossible to determine, the probabilities are that the majority of them originate from the pelvic mucosa. It would seem improbable, therefore, that the insignificant total of 179 cases collected from the literature by Smith and Gilbert,[1] in 1925, represents the true incidence of intrapelvic tumors. A few cases reported since 1925, including those of Day,[2] Meltzer,[3] and of White and Rich,[4] may be added, but the total is excessively small when compared with the great frequency of the rather closely related epithelial tumors of the urinary bladder. Approximately one-half of the recorded cases of intrapelvic neoplasm are to be found in the literature of the last twenty years, and a number of the most important papers have appeared very recently. This renewed interest in the subject is attributable, perhaps, to the more precise diagnostic means at our disposal, although few correct pre-operative diagnoses have been reported. Miller and Herbst[5] are credited with having made, in 1921, the first correct pre-operative diagnosis of a papillary tumor of the renal pelvis. Little effort has been made to differentiate by urography the papillary from the flat, or non-papillary, tumors of the pelvis, although clinical differences are clearly defined. Such clinical differentiation is rarely possible in the case of the non-papillary type of tumor before the disease has advanced to the inoperable stage. This is well illustrated by the case reported herewith, as well as by those described by Kretschmer,[6] Scholl and Foulds,[7] Wheeler,[8] Keynes,[9] and others. Ewing[10] classifies neoplasms of the renal pelvis as (a) benign papilloma, (b) papillary epithelioma, and (c) flat or alveolar carcinoma. The commendable simplicity of this classification becomes apparent in a review of the recorded neoplasms which are designated by a score of terms descriptive of their microscopic architecture.

The papillary tumors of the renal pelvis as encountered by the surgeon may be apparently benign, or possibly or obviously malignant. Infiltrating non-papillary, or alveolar, carcinomata are always malignant. A neoplasm which fulfills both the gross and microscopic qualifications of benignancy may

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prove to be most malignant, as evidenced by prompt local recurrence and metastatic dissemination. It is probably of little practical importance whether a papillary carcinoma has resulted from the malignant transformation of a primary benign growth, or has been malignant from its beginning. Peculiarities in the pathogenesis of intrapelvic tumors and their clinical features have been discussed at length by Albert Scholl,[7] Thomas and Regnier,[11] Gilbert and Smith,[1] and other recent writers. The consensus of opinion is that all papillary tumors are inherently malignant and that the microscopic characteristics of benignancy do not insure innocent behavior on the part of the tumor.

It is our purpose to present a series of seven cases of intrapelvic tumors, and to review the subject chiefly from the standpoint of diagnosis.

CASE I.—*Benign Papilloma of the Left Renal Pelvis.* M. B., fifty-four years of age, was admitted to the Pennsylvania Hospital September 14, 1928; discharged September 21, 1928. Readmitted October 15, 1928; discharged November 3, 1928. Chief complaint: blood in urine.

*History.*—Perfectly well until two weeks ago when he noticed bright red blood in his urine; this continued without interruption for about one week, then stopped off two days, after which he noticed blood again, and it has continued until the present (September 14). He thinks that the amount of blood has increased since the onset. There have been no clots—no other urinary symptoms—no dysuria or renal colic. He is a well-nourished adult male; no dyspnœa or cyanosis. Physical examination negative.

*Cystoscopy.*—No. 18 cystoscope introduced easily; bladder urine bloody, some blood clots in bladder, bladder is tolerant, moderate trabeculation; no cystitis. *Bloody urine seen coming from left ureter.* Prostate—moderate lateral and median lobe hypertrophy. *No neoplasms found.* Left ureter catheterized. Bloody urine from left kidney. This specimen was filled with blood, no pus, acid in reaction, free from casts, culture sterile, no acid fast organisms. Capacity of left kidney pelvis ten cubic centimetres.

Divided function (phthalein)—*appearance time:* Right, not taken; left, five minutes. *Percentage output:* First fifteen-minute collection—right, 10 per cent.; left, 5 per cent. Second fifteen-minute collection—right, 7.5 per cent.; left, 2.5 per cent. Total, 17.5 and 7.5 per cent., respectively.

*Plain Röntgenogram.*—Negative.

*Pyelography* (Fig. 1).—Stereoscopic pyelograms were made on September 18, 1928, and October 3, 1928; 12 cubic centimetres of 15 per cent. sodium iodide used. Pyelogram, Fig. 1 (Pennsylvania Hospital X-ray Laboratory, No. 67863), was reported as follows: "There is a defect in the region of the upper calix of the left kidney. I believe that it represents a lesion, possibly a tumor. Ureterogram normal." (Doctor Bowen.)

*Laboratory Data.*—Numerous studies failed to disclose tubercle bacilluria. The urine became chemically and microscopically normal soon after the hæmaturia ceased. September 14, 1928: hæmoglobin 83 per cent., red blood cells 4,230,000, white blood cells 7200, blood urea 14 milligrams.

*Pre-operative Diagnosis.*—Intrapelvic neoplasm—probably papillary in type, involving the upper calix and adjacent portion of the true pelvis.

The patient left the hospital but returned October 15 and the kidney was removed next day. At operation the kidney was grossly normal, but section after its removal disclosed the neoplasm described below. The ureter was normal. Convalescence was uneventful; the patient is without symptoms (February 1, 1929).

*Post-operative Diagnosis.*—Benign papilloma of the pelvis of the kidney involving the upper portion of the true pelvis and upper calix.
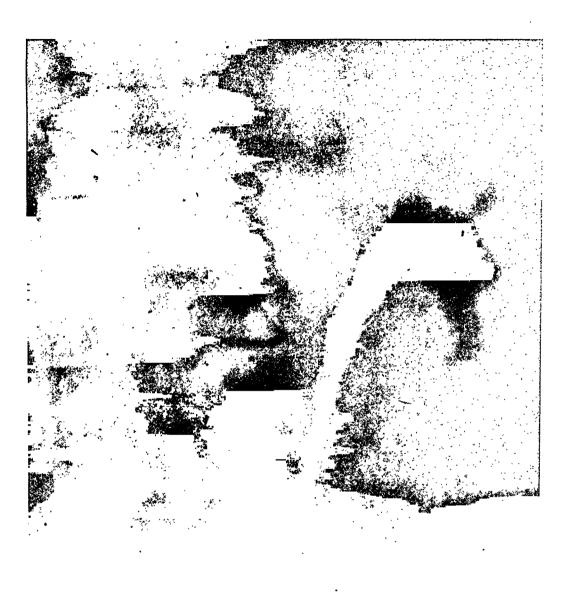
FIG. 1.—(Case I.) See also Figs. 2 and 3. Pyelograms in case of benign papilloma of the renal pelvis. Note the absence of the superior calix, the filling defect of the adjacent portion of the true pelvis and dilatation of one calix, due to partial occlusion of its ostium. To the inner side, the median extends upward, partly surrounding the neoplasm.

# PRIMARY NEOPLASMS OF RENAL PELVIS

*Laboratory Report.*—Surgical No. 13757. Specimen, kidney (Figs. 2 and 3). Date, October 16, 1928. The specimen of a longitudinally sectioned kidney measuring 11.5 x 5.5 x 5 centimetres. The capsule strips easily and discloses a finely granular, even surface throughout. The color of the kidney is normal; medullary tissue preponderates over the thinned cortical tissue, but the contrast is well maintained. There is a pale pink, cauliflower-like growth occupying the upper two-fifths of the pelvis. It is firmly bound to the pelvic membrane. It appears to be part of the membrane and, also, to be invading the upper calix to a moderate degree.

Further sections reveal very little invasion of the kidney parenchyma.

*Summary and Comments.*—A male, fifty-four years of age, had the initial and only urinary symptom, a frank hæmaturia, on September 5, 1928. October 5, 1928, the kidney was removed. Cystoscopic examination disclosed the source of the bleeding as the left kidney. While bleeding, this kidney failed to excrete phthalein in forty-five minutes, but when the bleeding had ceased the function was about half normal. There was no retention in the pelvis, proving the absence of an obstructive lesion. There was no demonstrable infection. The plain röntgenogram was negative. There were no neoplasms to be found in the bladder. The ureter was patulous.

The first pyelogram revealed a small filling defect in the upper portion of the true pelvis with effacement of the upper major calix. The defect did not explain satisfactorily the very much diminished renal function. A second functional study made after the hæmaturia had ceased disclosed only moderate dysfunction. (NOTE: A bleeding
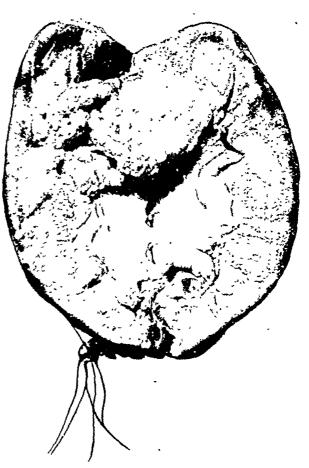


Fig. 2.—(Case I.) Benign papilloma of the renal pelvis. The size and position of the neoplasm explains the pyelographic defect (Fig. 1).

kidney, whatever the cause of the bleeding and however normal the organ, may show poor ability to eliminate dyes.) A second pyelogram disclosed not only the defect already noted, but also small crescentic streaks which extended upward from the filling defect indicating that the medium had surrounded an intrapelvic mass. This, together with the fact that the renal function was only moderately diminished, led to the diagnosis of intrapelvic tumor, while the configuration of the filling defect justified the belief that the tumor was papillary in type rather than flat. The normality of the bladder, as revealed cystoscopically, and the normal ureterogram indicated the absence of secondary implants. The tentative diagnosis of intrapelvic papillary new growth was confirmed at operation.

CASE II.—*Extensive Non-Papillary Carcinoma of the Right Renal Pelvis in a Negro.* E. J., negro, fifty-one years of age, was admitted to the Pennsylvania Hospital November 19, 1923; died December 18, 1923. Chief complaint: Pain in the right groin and leg.

*Present Illness.*—Perfectly well until June, 1923, when he first noted pain which rapidly increased in severity. The pain which was "dull and dragging", and worse at night, could be reduced somewhat by lying on his left side. He was confined to a hospital during July and August, and was somewhat improved by the rest. No urological

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examination made according to the patient. No treatment, and only moderate suffering until November, 1923, when he began to have severe pain in the right loin referred to the testicle and right leg. Pain increased by extending the leg. There is marked urinary frequency and dysuria. Has lost sixty-two pounds in weight. Patient states that he has had numerous chills. Had gonorrhœa and possibly chancre twenty-six years ago. (Wassermann now negative.)

*Physical Examination.*—Tall, emaciated, middle-aged negro who complains bitterly of pain in the right lower abdomen radiating downward. This pain is increased by deep breathing and movement of the leg. The entire right side of the abdomen is tender and very rigid. The extreme muscular rigidity precludes accurate abdominal palpation, but no definite mass can be outlined. There is no palpable enlargement of the left kidney. No tenderness in the left loin. The urine is pus-laden and contains some red cells. The specific gravity is low. November 21, 1923: Hæmoglobin 70 per cent., red blood cells 3,400,-000, white blood cells 20,600, urea nitrogen 24.2, creatinine 2.1.

*Cystoscopy* revealed extensive cystitis with marked œdema of the trigonal area. Ureteral orifices not found. Daily irrigations of the bladder ordered.



Fig. 3.—(Case I.) The tumor is a delicate papillary structure, growing in large irregular groups separated by delicate fibrous tissue septæ which are infiltrated with a few round cells. The cells comprising the tumor are columnar for the most part and show large, rather evenly staining nuclei, none of which show division. The basement membrane is not broken and no invasion of the underlying renal tissue, which, in general, is in a fair state of preservation, except for moderate degenerative changes of the tubular epithelium. The degree of malignancy is low, this structure suggesting a papilloma of the renal pelvis. (Bauer.)

Cystoscopy, November 27, 1923. Cystitis improved. Left ureteral opening in normal position. Pus-laden urine obtained by catheter from left kidney. Right ureteral orifice in mid-line of bladder—apparently a congenital anomaly. Right ureter blocked eight centimetres from orifice. No urine obtained.

Indigocarmine (intravenous) appeared from the left kidney in fair concentration in six minutes. None from the right kidney after fifteen minutes. The left urine was pus-laden, but sterile. Cystoscopy, December 3, 1923. Cystitis greatly improved. Hazy urine from left kidney. Right ureter blocked in mid-abdominal portion. No urine obtained. Indigocarmine eliminated by the left kidney in eight minutes in good concentration. None from the right in twenty-five minutes.

On December 10, 1923, bulging, marked rigidity and tenderness of right side of abdomen noted. However, the patient's general condition and renal function were improving. The urinary infection had improved markedly. The phthalein output (two hours' collection) had gradually increased to 65 per cent.

Plain skiagrams were of no assistance in diagnosis.

Cystoscopy, December 11, 1923. The improvement of the cystitis and left renal infection continues. Indigocarmine is now eliminated from the left kidney in five minutes in full concentration. The right kidney is functionless. The right kidney is unquestionably dead, and the left kidney, which was badly infected and low in function, has improved in function and is now mildly infected.

*Pre-operative Diagnosis.*—Functionless right kidney; possibly an infected malignant kidney. (In a very similar case the condition proved to be an infected sarcomatous kidney; in this case pyelographic distortion led to the diagnosis of infected renal neoplasm.) Obviously the case under discussion was not an ordinary pyonephrosis but, owing to ureteral occlusion, pyelographic study was impossible. However, it seemed advisable to explore the kidney transperitoneally. This was done by one of our confreres.

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The left kidney was apparently normal, the right one extensively diseased. The mass which was very hard and nodular and densely adherent extended well beyond the mid-abdominal line and below the umbilicus. The mesenteric glands were enlarged and indurated. Mobilization of the mass was attempted, but the patient died before this could be accomplished.

*Pathological Report* (Figs. 4 and 5).—Surgical No. 9877. Specimen, growth and kidney. Date, December 18, 1923. This specimen consists of a large kidney weighing



Fig 4.—Non papillary carcinoma of the right renal pelvis.

530 grams. It is covered with patchy hæmorrhagic areas, but, for the most part, the parenchymatous portion is quite pale in color. Scattered over the surface are many elevated irregularities, some of which appear as cauliflower-like projections and others as rounded elevations from an inner saccular dilatation.

On opening, the picture in general is that of a hydropyonephrosis. The pelvis is found to be dilated and filled with purulent fluid. There is an extreme degree of destruction of renal tissue with many saccular dilatations of the calices which extend through medullary and cortical portions of the parenchyma. In the pelvis there is a large cauliflower-like mass of pale semi-friable tissue protruding into the pelvis lumen, partially obstructing the ureteral orifice. It cannot be said, from gross examination, to exhibit the appearance of a papillary type of growth. This type of tissue which is most

prominent in the pelvis seems to spread out in a thick layer (5 millimetres) which lines the dilated calices throughout the renal parenchyma and is seen as a yellowish lining in contrast to the fibrosed renal tissue beneath. Evidences of an acute suppurative process mask the picture somewhat.

*Microscopical Examination* (Fig. 5).—The microscopic picture is masked by the presence of an acute suppurative infection with a great deal of associated necrosis. Sections of the pelvic mass show that it is composed of infected tumor tissue. The majority of the tumor cells are large, slightly elongated and occasionally fusiform, seen lying in small groups surrounded by a very fine network of thread-like fibrous stroma. A heavy fibrous stroma, however, is seen ramifying here and there through the mass, but the relation of the tumor cells to this stroma is not clearly defined. It does not appear to be that seen in a papillary type of growth. Evidences of acute and chronic infection are prominent with a great deal of necrosis, enormous numbers of polymorphonuclear leucocytes and occasional giant cells. The same type of tumor tissue, noted in the pelvic mass, is seen lining the dilated calices in which strands of tumor cells line and penetrate into the underlying fibrous tissue. This is evidently an epithelial tumor arising from renal pelvis of distinct malignancy. The type is not clearly defined.



FIG. 5.—(Case II.) See also Fig. 4. This represents the most malignant of the series. While the section reveals a greater atypical papillary arrangement with little stroma, the cells themselves are more irregular in shape and size, at places produced tumor giant cells with hyperchromatic nuclei. The degree of invasion, however, cannot be satisfactorily determined, for a massive acute infection, evidenced by polymorphonuclear cells, masks the picture by infiltrating the entire remaining renal tissue. The compression of renal tissue and the lack of a basement membrane are readily indicated. (Bauer.)

*Diagnosis.*—Carcinoma of renal pelvis. Pyonephrosis.

NOTE.—Sections seen by Dr. J. McFarland, University of Pennsylvania, agree with above diagnosis. No further classification made. We report the case as one of non-papillary carcinoma on account of the extensive flat growth involving the pelvic walls (Fig. 4), and the absence of a typical papillary structure in the microscopic sections.

CASE III.—*Papillary Carcinoma of the Left Renal Pelvis. Carcinoma of the Right Kidney. Source Undetermined. Possibly a Primary Papillary Neoplasm of the Pelvis. Multiple Implants in the Bladder.* C. E. J., fifty-nine years of age, white, was admitted to the Pennsylvania Hospital June 5, 1924, referred by Dr. John H. Gibbon for diagnostic study. Chief complaint: Hæmaturia.
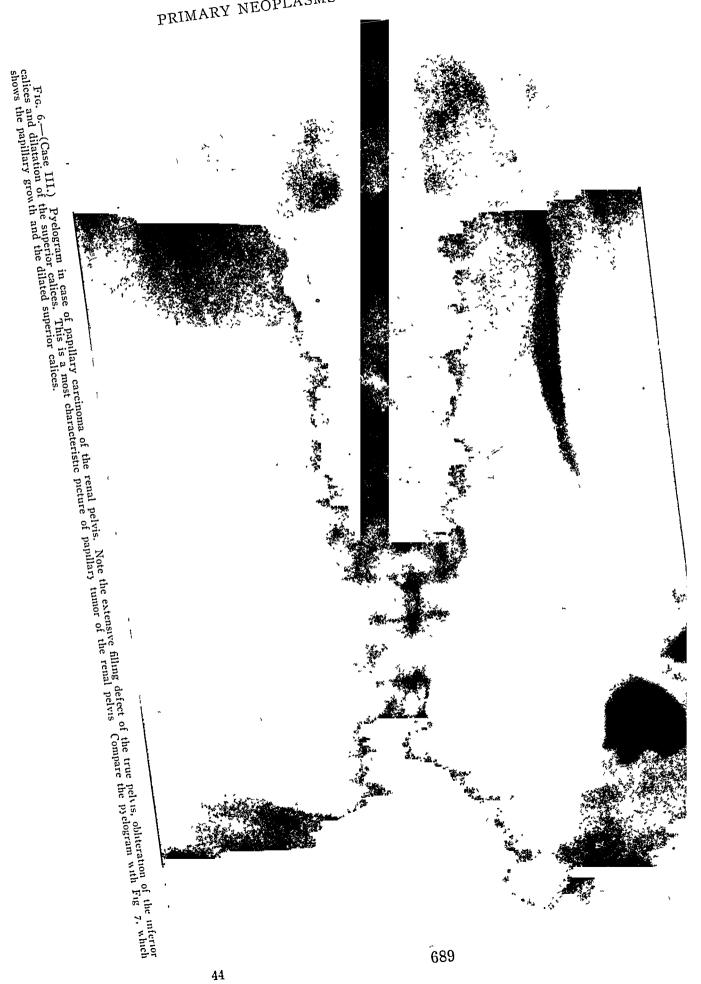
*Present Illness.*—Onset October 23, 1923, with hæmaturia which lasted a few days, reappearing three weeks later. Hæmaturia has continued intermittently until the present. No other symptoms.

Three weeks ago was seized with pain in the left mid-abdomen which shifted to the left flank and continued for three hours. No change in the urinary symptoms.

*Past Medical History.*—Gonorrhœa at nineteen. Fracture of the pelvis three years ago.

*Physical Examination.*—Negative except for an indefinite mass in the upper right abdomen. This mass was not identified but was, in all probability, the kidney. The left kidney which contained the papillary tumor could not be felt.

*Cystoscopy* revealed a trabeculated bladder. No diverticulæ seen. Three small papillomata on posterior wall of the bladder, size of small peas. Moderate intravesical enlargement of the prostate gland. Large amounts of blood ejected in spurts from the left ureteral orifice. No blood from the right. No. 6 catheters to the kidney pelves.

FIG. 6.—(Case III.) Pyelogram in case of papillary carcinoma of the renal pelvis. Note the extensive filling defect of the true pelvis, obliteration of the inferior calices and dilatation of the superior calices. This is a most characteristic picture of papillary tumor of the renal pelvis. Compare the pyelogram with Fig 7, which shows the papillary growth and the dilated superior calices.

Bloody urine from the left kidney. Hazy urine from the right kidney. Cultures of these specimens were sterile.

Divided function (phthalein)—*appearance time:* Right, three minutes, good concentration; left, seven minutes, moderate concentration. Owing to patient's intolerance to instrumentation collections for percentage estimation of the dye were not made.

*Pyelography* (Fig. 6).—No. 6 catheter to pelvis of left kidney; considerable thick white fluid obtained. No blood. Pelvic capacity slightly increased. Twelve cubic centimetres of 25 per cent. sodium iodide injected. The pyelogram, Fig. 6, shows a characteristic filling defect due to intrapelvic neoplasm with secondary dilatation of some of the calices. We did not make this diagnosis positively notwithstanding the presence of implants in the bladder. We did advise renal operation, however, with the statement, "I am inclined to believe that this is a case of bleeding nephritis, although the possibility of bleeding neoplasm cannot be excluded. I would advise exploration of the left kidney. The right kidney seems to be slightly decreased in function".



FIG. 7 —(Case III ) Kidney containing a papillary tumor occupying the true pelvis and inferior calices Note the dilated ostium of a superior calix above the mid-line of the kidney and a dilated calix at the upper pole. Compare these findings with pyelographic defect (Fig. 6).

Owing to the poor general condition of the patient and evidences of nephritis, it was decided to postpone operation for a brief time. After the hæmaturia ceased the urine became essentially normal except for a fixed low specific gravity and faint traces of albumin. There was a moderate degree of secondary anæmia: hæmoglobin 65 per cent., red blood cells 2,820,-000, white blood cells 13,200. The blood chemistry was as follows: Sugar 103 milligrams, urea nitrogen 16.8 milligrams, creatinine 1.6 milligrams.

*Second Admission.*—July 1, 1924, two days before re-admission the patient had a violent attack of pain in the left flank following which he passed large amounts of clotted blood.

*Operation* July 7, 1924, by Doctor Gibbon. Curved left lumbar incision. Enlarged congested kidney exposed and removed. There was no evidence of metastases or involvement of the perirenal fat which was, however, somewhat thickened and indurated. On incision of the kidney a papillary mass was found in the pelvis. The convalescence was uneventful except that slight hæmaturia persisted and the urine contained considerable pus. Prior to operation the specific gravity was persistently low and the highest phthalein elimination was 32 per cent.

*Pathological Report* (Figs. 7 and 8).—The kidney (Fig. 7) measures twelve centimetres in length, and presents a slightly congested surface and enlarged pelvis. Bulging from the pelvic wall is a cauliflower-like growth, 3 x 2 centimetres, which is rounded and has a granular, crumbly centre. On laying open the kidney, an area of necrosis with carcinomatous infiltration is exposed beneath the pelvis. The rest of the kidney is pale and looks degenerated, but no growths outside of the mass mentioned can be made out. Firm white hyalin-like tissue surrounds the growth.

*Additional Data.*—We hoped to destroy the bladder papillomata by electrical desiccation but found that in the interval a dozen or more growths had appeared, some of them situated in the region of either ureteral orifice. These implants grew with astonish-

ing rapidity, far more rapidly than any benign papillomata of the bladder, although they presented no tendency to infiltrate the bladder wall. The mass in the right flank, noted above, became more easily palpable. On October 29, 1924, Doctor Gibbon explored the abdomen and found an extensive carcinoma of the right kidney pelvis with nodular involvement of the parenchyma and metastases to the liver. The patient died in coma on December 12, 1924.

*Summary and Comments.*—The patient, a man, fifty-nine years of age, had intermittent hæmaturia from October, 1923, until his admission to the Pennsylvania Hospital in June, 1924. During this time three physicians failed to make a diagnosis. A cysto-scopist failed to find either the source or the cause of the bleeding. In June, 1924, several small papillomata were found in the bladder; the left kidney contained a bleeding lesion and was diminished in function. The right kidney was likewise slightly diminished in function, but was not bleeding. There was a palpable mass in the upper right abdomen, the identity of which was not made with certainty. Our pyelographic studies indicated the presence of a serous left renal lesion and the defects disclosed (Fig. 6) were typical of intrapelvic tumor, although this diagnosis was made only tentatively in the case. As the result of the study, however, nephrectomy was decided upon. The kidney contained a large papillary carcinoma of the pelvis.

The implants in the bladder grew with great rapidity, not in size alone, but also in number. The futility of fulguration became evident. A palpable mass, possibly of right renal origin, grew in size. Exploration proved this to be a carcinomatous kidney. There were metastatic nodules in the liver. This case indicates the advisability of bilateral pyelography. It is possible that the neoplasm of the right kidney in our case was metastatic from the neoplasm of the left kidney. Metastatic carcinoma of the kidney is not uncommon.



Fig. 8.—(Case III.) The structure of this is very much like that of Fig. 3 (Case I), and reveals a thick epithelial papillomatous structure in which the cells deviate very little from that of the normal epithelium, although definitely increased in amount. The basement membrane appears to be broken at places. Cellular infiltration beneath the tumor indicates a reaction against its proliferation and invasion. Again few changes are seen in the renal parenchyma, although moderate scarring, hæmorrhage and cellular infiltration of an inflammatory type exist.

CASE IV.—*Papillary Carcinoma of the Right Renal Pelvis with Secondary Hydronephrosis and Ureteral Implant.* E. A. R., female, white, sixty-eight years of age, was admitted to the Pennsylvania Hospital May 19, 1922. Chief complaint: Hæmaturia. Intense steady pain in the right lumbar region and right hip.

*Present Illness.*—Began three months before with severe aching pain in the right loin and right hip. This has been constant although somewhat relieved by lying down. Several attacks of hæmaturia during which there have been dysuria and frequency. Has lost much weight. Appetite poor. Quite weak. Sleeps poorly and is extremely nervous.

*Past Medical History.*—One severe preliminary hæmorrhage fifteen years ago. Six attacks of rheumatic fever.

*Physical Examination.*—Poorly nourished, anæmic elderly female. Complains of constant severe pain in right loin and hip. Patient is somewhat deranged mentally. There is considerable myocardial weakness and a systolic apical murmur. Some dulness over both apices. Abdominal examination discloses muscular rigidity on the right side and tenderness over the right loin and right iliac area. No masses palpable. Subsequently we could palpate a large kidney mass on the right side. (Intermittent hæmatonephrosis?) The urine was laden with blood cells. Wassermann negative. Two hours' phthalein output—20 per cent. Hæmoglobin 70 per cent., red blood cells 4,230,000, white blood cells, 10,800.

*Cystoscopy.*—Bladder urine clear. Bladder tolerant and capacious. Sphincteric margin studded with small cysts. Left ureteral orifice normal. Projecting from the right ureteral orifice is a plug of mucus. The orifice is surrounded by œdematous mucosa and just posterior to it there is a solid neoplasm (Fig. 9) which seems to have broken through the roof of the ureter to enter the bladder. The ureter is obstructed at this point. Left ureter admits catheter. Urine clear. No pelvic retention.

Divided function (phthalein)—*appearance time:* right, none in forty minutes; left, three minutes. The right kidney is functionless, the left one somewhat impaired in function as indicated by a total output in two hours of only 20 per cent.

*Röntgenograms.*—No evidence of calculi. There is an advanced osto-arthritis involving all the limbs and part of the dorsal spine. The chest is negative. No evidence of metastatic neoplasm.

*Operation.*—June 13, 1922. Lumbar nephrectomy. There were dense adhesions in the region of the uretero-pelvic junction. The ureter was much thickened and adherent. There was no palpable evidence of ureteral involvement except in the upper portion. The kidney was large and apparently hydronephrotic. Convalescence uneventful except for mental condition. June 30, 1922, fifty milligram hours of radium were applied to ureteral tumor.

*Post-operative Course.*—The patient developed increased psychic symptoms of the paranoid type, and was transferred to the Philadelphia Hospital where she remained five months. Since her discharge we have been unable to trace her.



Fig 9 —(Case IV.) See also Fig. 10 Carcinoma of the lower ureter secondary to carcinoma of the renal pelvis The neoplasm has ulcerated through the ureter to invade the bladder.

*Pathological Report.*—The specimen is a kidney (Fig. 10) measuring 11.5 x 5 x 3 centimetres. The centre is thinned to three millimetres. The pelvis is dilated together with the calices. The upper ureter and adjacent segment of the true pelvis are represented by a hard thick mass of tissue. NOTE.—Grossly this neoplasm seemed to be a flat non-papillary neoplasm possibly of the squamous-cell type. Recent studies of the specimen by Dr. Charles Bauer have disclosed certain areas in which the tumor-cell arrangement suggests pearly body formation, but the essential architecture is papillary and the neoplasm is so classified. Doctor Bauer's description of the microscopic features accompanies. (Fig. 11.)

*Summary and Comments.*—Both the renal enlargement and pain in the case were probably caused by the hydronephrosis rather than by the neoplasm itself. The presence of a ureteral tumor causing occlusion prevented pyelographic study of the kidney on the involved side; this would have failed, however, to disclose the condition no doubt on account of upper ureteral closure grossly; the neoplasm seemed to us to be non-papillary in type, but apparently the superficial fimbriæ had been destroyed, leaving a flat surface. The presence of an implant in the ureter was suggestive of a primary papillary tumor of the kidney pelvis since non-papillary neoplasms do not give rise to implants. From the microscopic standpoint this tumor was more malignant than that in Case I and less malignant than that in Case III.

CASE V.—*Papilloma of the Left Renal Pelvis with Ulceration of the Pelvic Walls and Extravasation of Urine.* J. S., male, white, fifty-two years of age, presented himself for office examination with the statement that he had fallen from a chair, landing on his buttocks, and that twenty hours thereafter he developed a symptomless hæmaturia lasting two days. The left kidney was found to be the source of cloudy urine containing blood.
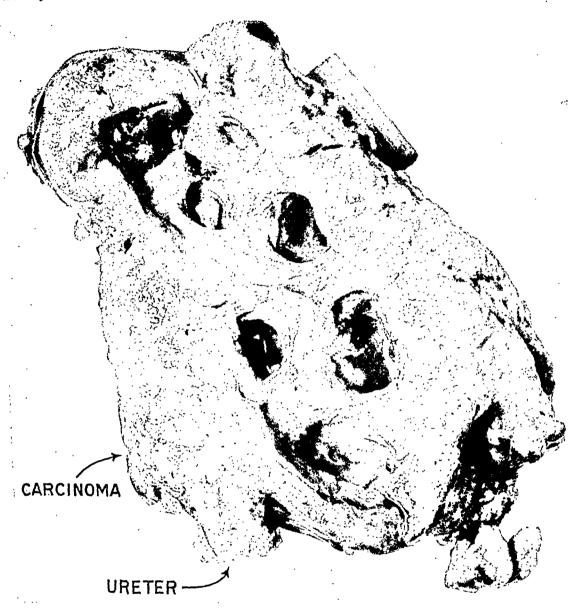


FIG. 10.—(Case IV.) Apparently, a flat carcinoma at the uretero-pelvic junction with hydronephrosis. This was associated with ureteral implant (Fig. 9). Doctor Bauer finds that the tumor is papillary in type (Fig. 11). The kidney was closed.

The bladder was normal. The patient entered the hospital May 6, 1926; the following data are taken from the hospital records:

Chief complaint: Hæmaturia.

*Present Illness.*—Six weeks ago had a fall (as above stated) followed by hæmaturia. The latter disappeared after two days, but recurred four days before admission to the hospital. No other symptoms.

*Past History.*—Seven years ago had a severe attack of colicky pain in the left lumbar region. This was relieved by an injection of morphine. There was no gross hæmaturia. There has been no recurrence of the pain which during the initial and only attack persisted with more or less intensity for two months.

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*Cystoscopic Examination.*—Bladder normal. No. 6 catheters to the renal pelves. No ureteral obstruction demonstrable. No pelvic retention. Clear urine from the right kidney. Bloody urine from the left kidney.

Divided function (phthalein)—*appearance time:* Right, four minutes; left, none in twenty minutes. *Percentage Output:* Fifteen-minute collection—Right, 20 per cent.; left, none.

*Pyelogram.*—Notwithstanding the absence of demonstrable retention sixty cubic centimetres of sodium iodide was injected into the left kidney without causing pain. Unfortunately, this pyelogram cannot be found, but it was reported as showing "a filling defect probably caused by a tumor". The total phthalein output was 20 per cent., urea nitrogen 21.6 milligrams, creatinine 1.6. The Wassermann was negative.

The patient left the hospital but returned May 25 for operation. Medical consultant advises that digitalis be given prior to operation on account of myocardial weakness. At this time no abdominal masses were palpable.

A second pyelogram (Fig. 13) was made, using 80 cubic centimetres of sodium iodide. This is reported as showing "renal enlargement at the expense of the kidney substance as well as the pelvis of the kidney". It will be noted that there is a marked filling defect associated with dilatation of certain calices and a large fan-shaped shadow extending outward from the region of the filling defect. This we were unable to explain, but we felt quite certain that the condition was one of papillary neoplasm of the renal pelvis. The patient's condition improved somewhat. On May 25, the phthalein output was 43 per cent. On June 6 a very serious hæmorrhage occurred—so serious that immediate nephrectomy became necessary. The kidney and perirenal fat were removed *en masse* without serious difficulty, but the patient died of cardiorenal failure and hypostatic pneumonia on June 12, following.

*Pathological Report* (Figs. 12 and 14).—Specimen is a thick-walled sac within which are the remnants of a kidney. The sac comprises



Fig. 11.—(Case IV.) The tumor of this kidney is a definitely papillomatous structure, much more advanced in degree of proliferation than the former one, and the epithelial cells comprising it show all changes from regular columnar-shaped, transitional epithelium to enlarged cells with atypical pale vesicular nuclei in which the chromatin is distinctly increased in staining reaction and amount. Some of these cells are arranged in an oval manner suggesting the formation of epithelial pearls. The renal tissue has been greatly compressed, destroyed, invaded by the papillomatous structure and greatly infiltrated with cells. Unquestionably there is a hydronephrosis produced by the papillomatous structure which is definitely malignant and represents in this series a more malignant condition than Fig. 3 (Case I).

greatly thickened perirenal fascia and fat. It is irregular in shape but measures 15 x 8 x 7 centimetres. The remnants of the kidney measure 10 x 5 x 4 centimetres. The kidney is attached firmly to the sac wall except posteriorly where a cavity separates the two structures. This cavity represents the perirenal space, a portion of which has been walled off by reactive inflammation in the perirenal fat. No tumor is visible from the outside, but the pelvic cavity and perirenal space communicate. There is a small amount of bloody fluid in the perirenal space. On section the kidney tissue is found to be much thinned out in places, thickened in others; some calices are dilated, others obliterated. There is a mass of fairly firm pale-colored tissue almost filling the pelvic cavity and attached to it broadly. On section this mass appears to be softened and partly necrotic. The renal parenchyma presents marked fibrosis, but there is no infiltration of tumor cells.

Sections of the central mass show typical papilloma in which fairly thick coils of
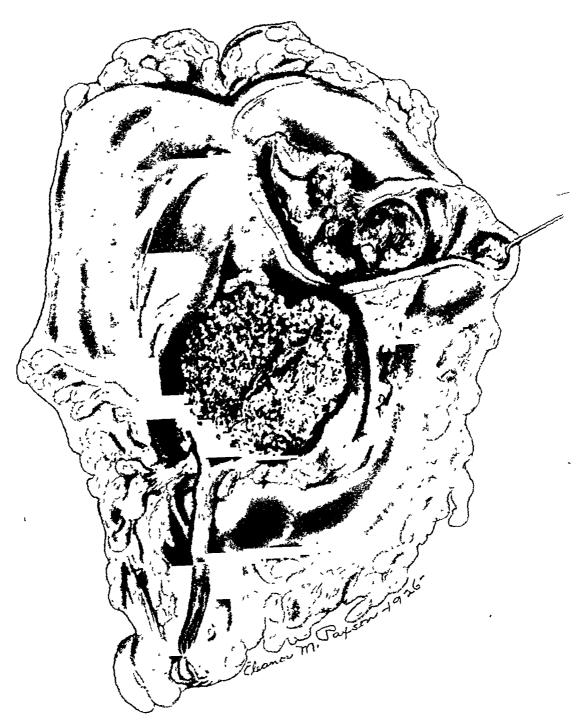
Fig. 12 —(Case V.) Kidney containing a large papillary tumor of the true pelvis with extensions into some of the calices. The superior calices are dilated (see Fig. 13). Note the marked thickening of the perirenal fat and the space between the latter and the kidney into which the pyelographic medium gained entrance through a rent in the true pelvis.

FIG. 13.—(Case V.) Pyelogram showing the most typical feature of deformity due to papillary intrapelvic neoplasm, namely, filling defect of the true pelvis, obliteration of the lower calices and dilatation of the superior calices. Note the large shadow below and to the outer side of the filling defect. This, which we were unable to explain, represents medium which has found its way through a rent in the pelvis into the perirenal space behind the kidney. (See Fig. 12.)

connective tissue are surrounded by several layers of epithelial cells. No masses. of epithelium or other malignant features noted. (Fig. 14.)

*Diagnosis.*—Papilloma of the renal pelvis with pelvic ulceration permitting extravasation of urine.

NOTE.—I think that serial sections of this tumor would have disclosed papillary carcinoma (Herman).

SUMMARY AND COMMENTS.—This patient apparently had a papilloma of the left kidney for a long time—possibly seven or more years. Trauma may have been influential in causing necrosis leading to hæmaturia. There is a possibility that the distention of the kidney during pyelography promoted ulceration of the pelvic walls leading to urinary extravasation. It is also possible that the serious hæmorrhage which occurred nine days after the last pyelography was caused by renal distention. The pyelograms were made without pain, however, and there were no clinical signs of renal rupture which apparently occurred very slowly as the result of neoplastic and inflammatory erosion. The pyelogram shows not only the filling defect and dilatation of some of the calices suggestive of intrapelvic tumor, but also a collection of medium behind the kidney.

This patient's death was due largely to the serious renal hæmorrhage which occurred shortly before operation.

CASE VI.—*Extensive Renal Carcinoma Probably of Pelvic Origin.* The following case was studied by Doctors Lippincott and Bentley, of Camden, N. J., to whom we are indebted for the clinical notes and pyelogram (Fig. 15). C. A., male, white, sixty years of age, was admitted to the Cooper Hospital, July 5, 1928. The chief complaints were pain in the left side and weakness.



FIG. 14.—(Case V.) Papilloma of the renal pelvis; no evidence of malignancy. (See Figs. 12 and 13.)

The present illness had lasted one year. Initial symptoms brick dust appearance of the urine. Slight frequency. Gross, painless, intermittent hæmaturia soon developed. Four months before admission he began to have fixed pain in the upper left abdomen. The pain and hæmaturia became progressively worse. Weakness has been noted for several weeks.

*Physical Examination.*—Well-nourished adult male. No abnormal findings except tenderness and rigidity over the upper left abdominal quadrant. No definite mass found. No evidence of metastases. The urine contained blood. Blood chemical studies were essentially normal. There was mild anæmia. The Wassermann test was negative. Prostate not enlarged to rectal examination.

*Cystoscopy* (Doctors Lippincott and Bentley).—Bladder urine clear. Bladder normal. Considerable intravesical enlargement of the prostate gland. Clear urine obtained from the right kidney. The catheter on the left side became occluded by blood clots and had to be replaced; after this, the urine collected from the left kidney was clear.

Indigocarmine appeared in five minutes from the left, and in four minutes from the right kidney. The renal function seems to be normal.

*Pyelography* (Fig. 15).—Twenty cubic centimetres of sodium iodine solution injected into the left renal pelvis—no pain. At another time a double pyelogram was made to compare the shape of the two pelves.

*Subsequent Course.*—The patient had no further treatment until December, 1928, when he was admitted to the Burlington County Hospital, New Jersey, under the care of Doctor Reimer, with whom we saw the case in consultation. At this time, the man

was emaciated and anæmic. The pain and hæmaturia had persisted more or less constantly. The mental condition had cleared up, but there was a constant severe boring pain in the lower left chest and upper abdomen. It had been necessary to use opiates



FIG. 15.—(Case V.) Note the filling defect of the true pelvis, distention of the upper portion with filling defects, and small filling defects of the lowermost calix.

for some time to control this pain. We could not outline a mass in the renal area nor could evidence of metastases be found.

On the basis of the pyelographic findings of Doctors Lippincott and Bentley and the course of the disease we were of the opinion that the condition was one of inoperable renal carcinoma. The kidney was explored through a loin incision. The organ

was found to be enlarged moderately, nodular throughout, a stony hard and densely adherent. Attempts to remove it seemed to us to be contraindicated.

SUMMARY AND COMMENTS.—The pyelogram (Fig. 15) which shows a marked filling defect of the true pelvis, invasion of the upper pole of the kidney and dilatation of the lower calices, indicated the presence of an extensive intrapelvic neoplasm, probably papillary in type and, in all probability, carcinomatous.

Normality of function of this kidney in July, 1928, would indicate that the parenchyma was little involved at this time, although the pyelogram suggests considerable parenchymal invasion. At operation five months later the entire kidney was involved; it had become inseparably bound to the perirenal structures and, in all probability, metastasis had already occurred.

CASE VII.—*Papillary Carcinoma of the Left Kidney.* J. P., white, sixty years of age, was admitted to the Methodist Hospital, of Philadelphia, on account of hæmaturia, beginning one month ago when the patient passed a red, pencil-like mass in the urine. This he describes as snake-like and about six inches in length. Six years ago there was an attack of lumbar pain (side not stated) lasting one week. There had been no symptoms following this until one month ago. On admission to the hospital the man was having great bladder distress. There was some residual urine. The urine was filled with blood. The prostate gland was moderately enlarged, but not indurated. A medical consultant reported moderate chronic myocarditis and the presence of râles in both lungs (basal).

There was moderate secondary anæmia: hæmoglobin 73 per cent., and the functional studies showed marked renal dysfunction. The highest phthalein elimination was 10 per cent. for a two-hour period. The blood urea nitrogen was 38.5 milligrams.

*Cystoscopic Studies.*—The initial cystoscopy disclosed a rigid deep urethra. The bladder was filled with bloody urine and clots. There was very marked trabeculation. The viscus was large in capacity, but during cystoscopy was intolerant so that an imperfect view was obtained. The entire trigone and sphincteric margin were studded with small cystic bodies and there was considerable œdema. There were several ecchymotic areas surrounding the right ureteral orifice. We could not rule out with certainty a basal carcinoma.

A second cystoscopic examination was made August 10, 1927, for the purpose of reëxamining the bladder and study of the upper urinary tract. The source of the bleeding had not been determined. The patient had great bladder distress and was rapidly losing ground. Again it was found impossible to catheterize the ureters on account of extensive œdema. We were of the opinion, however, that the hæmaturia was of upper urinary origin on account of the history of the passage of ureteral (worm-like) clots, absence of a demonstrable bleeding lesion of the bladder, and the low renal function. Due to the latter, the indigocarmine test was of no service in locating the ureteral orifices.

*Treatment.*—The intensity of the patient's bladder distress and the probability of improving renal function thereby prompted us to drain the bladder. This was done by Doctor Greene August 15, 1927.

A third attempt to determine the source of the hæmaturia was made after the cystotomy and we succeeded in introducing a catheter into the left ureter for a distance of six centimetres and recovered clear urine. There were no palpable masses present and the plain skiagrams were of no diagnostic assistance. The patient died September 6, 1927. The autopsy specimen (Fig. 16) is that of a large papillary carcinoma of the left kidney. Death was caused by bronchopneumonia and renal failure.

CASE VIII.—*Hypernephroma.* J. K., fifty-two years of age, was admitted to the Pennsylvania Hospital January 31, 1928, complaining of right-sided renal colic and massive hæmaturia. He had been perfectly well until the day before admission when he was seized with agonizing pain in the right renal area, followed by hæmaturia. The patient states that he has passed little urine since the onset of his present trouble, but has had great dysuria.

*Physical examination* revealed signs suggestive of an ancient apical tuberculosis of the left lung, the presence of which was confirmed by the skiagram. There was some tenderness in the right renal area. There was no enlargement of the prostate gland to
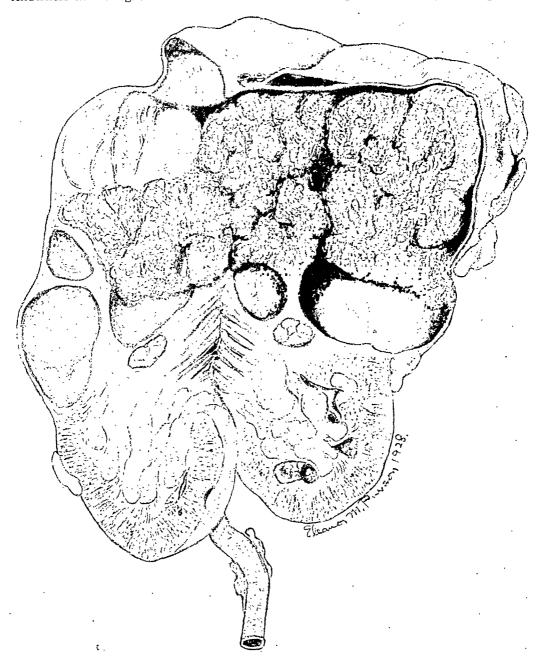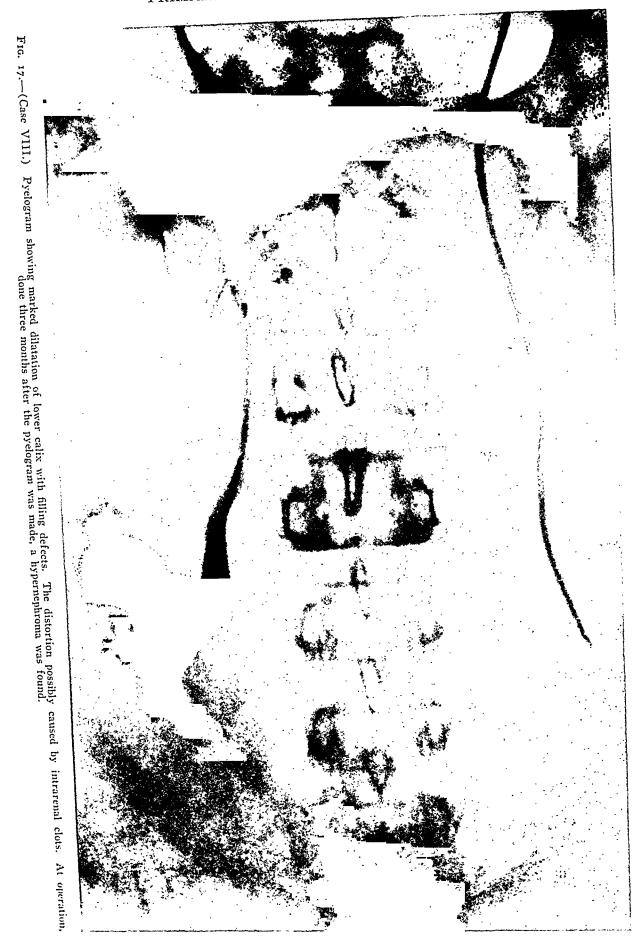


FIG. 16.—(Case VII.) Kidney, the upper portion of which contains a large papillary carcinoma. Note the great thinning of the cortex in the area and the widely dilated calices below the site of the tumor which originated in the true pelvis. The lower pole of the kidney is essentially normal.

rectal examination and no genital nodulation suggestive of tuberculous infection. The bladder was distended with thick blood clots which were removed by catheter irrigation, but only after repeated washings.

*Cystoscopic Data.*—The initial cystoscopy (February 2, 1928) was not wholly satisfactory, but we succeeded in determining that the right kidney was the source of considerable hæmaturia, and that it secreted only traces of phthalein after thirty minutes.

FIG. 17.—(Case VIII.) Pyelogram showing marked dilatation of lower calix with filling defects. The distortion possibly caused by intrarenal clots. At operation, done three months after the pyelogram was made, a hypernephroma was found.

A pyelogram was made after injecting twenty-five cubic centimetres of sodium iodide solution, disclosing the defect shown in Fig. 17.

A second cystoscopic examination (February 10, 1928) disclosed a moderate median bar obstruction with considerable trabeculation, but only slight residual urine. There were no tumors in the bladder. The right ureteral orifice was slightly œdematous; the left one normal. Clear urine was obtained from the right kidney at first, but after pyelography it became very bloody. The left urine was hazy. The right kidney excreted phthalein in five minutes, the left one in three and one-half minutes. Fifteen-minute collections showed a percentage output of 10 per cent. from the right and 25 per cent. from the left kidney.

A second pyelogram was made which reproduced the deformity disclosed in the first study. Plain röntgenograms were negative for stone or renal deformity. The divided urines were sterile and free from tubercle bacilli.

*Discussion.*—This middle-aged man had a massive hæmaturia from the right kidney one day before hospital admission. There was the initial symptom. Examination disclosed reduction in function of the involved kidney to about one-half the normal after the bleeding had ceased. The pyelograms showed a pelvic deformity involving chiefly the lower major calix. (Fig. 17.) The latter is obviously dilated. There is perfect regularity of its margins which would tend to rule out an ulcerous cavity or a tumor which had invaded the calix from the parenchyma. There is no evidence here, or in the shadow of the true plevis, of pressure from without, nor is there elongation with narrowing of any of the calices such as occurs in hypernephromata. It will be noted that there are several light areas which we interpreted as filling defects in the distended calix. The patient refused operation and was discharged. The subsequent course of the case is given us by his physician.

Soon after leaving the Pennsylvania Hospital, he was examined elsewhere and no renal abnormality was found. Three months later he had a second serious hæmorrhage from the kidney. At operation, done elsewhere, a tumor-bearing kidney was removed. The growth proved to be a hypernephroma. The pyelographic defect was probably caused by distention of the calix due to massive hæmorrhage with intrapelvic clotting.

## NON-PAPILLARY NEOPLASMS OF THE RENAL PELVIS

Non-papillary carcinomata of the renal pelvis comprise a small excessively malignant group. The collected series presented by Kretschmer [6] in 1917 included forty-three cases to which may be added five cases reported by Scholl and Foulds,[7] one each by Keynes [9] and Wheeler,[8] and the case (Case II) included in this report.

It is agreed that primary non-papillary neoplasms of the renal pelvis originate from the transitional epithelium, but the parent cells are probably not cells normal to the part, but certain ones which have become squamous in type as the result of metaplasia, or true ectodermic cells representative of developmental inclusions. In the older literature these new growths are described under a great variety of terms, the one most commonly used being pavement-cell epithelioma. Newman [12] claims that only nine properly recorded cases of squamous-cell tumors of the kidney are to be found in the literature up to 1915, while seventeen of Kretschmer's [6] forty-three collected cases were considered to be epidermoid in type. The recent tendency, as shown in the paper by Scholl and Foulds,[7] is to classify non-papillary growths as squamous-cell epitheliomata, but it would be advantageous to apply the term epidermoid to those rare cases in which keratinization and pearly body formations occur.

There would seem to be no question but that chronic irritation is an important predetermining factor in squamous-cell epithelioma of the renal pelvis. This is evidenced by the fact that chronic bacterial inflammation is usually present, and stones as well in about one-half the cases.[13] Leucoplakia resulting either from the foregoing factors, or arising as a developmental condition, frequently antedates the onset of malignancy, which latter may be found in some instances to develop from the margins of a leucoplakial plaque. These have been the accepted facts for many years and recent writers find no reason to deny them. Of the early pathogenesis of the disease little is known. Few specimens have been subjected to study in the early stage of the neoplasm, partly because the latter is usually asymptomatic at first, but principally, we think, because it is excessively malignant. Wheeler [8] records the development of a malignant tumor in the renal area following nephrectomy for a supposed uncomplicated calculous pyonephrosis. Reëxamination of the specimen disclosed a small carcinoma involving the lower calix. This illustrates what is, in all probability, a characteristic feature of the disease, namely, early dissemination of the tumor cells. The probabilities are that this usually occurs before the neoplasm has given clinical evidence of its presence.

One type of tumor, as disclosed in the study of operative and necropsy specimens, is characterized by early replacement of the renal parenchyma by tumor cells and fibrosis leading to enlargement, induration, nodulation and dense fixation of the kidney. This type is usually associated with calculi. Early ureteral occlusion with the development of large hydronephroses is typical of the second type, and while parenchymal involvement is retarded in this variety, cure by operation, as in the case of the widely disseminated group, is rarely attained. Early metastasis by way of the lymphatics probably occurs very early in the course of squamous-cell tumors of the renal pelvis whatever gross form the primary growth assumes. Renal dilatation may perhaps account for the pain and the presence of a palpable renal mass in some few instances, but in the majority the former is due to perirenal nerve involvement, the latter to carcinomatous infiltration of the parenchyma. These manifestations of the disease usually denote inoperability.

In seeking to find, in historical data, some hope for earlier recognition of the disease, one meets with cases in which the history of hæmaturia or renal pain long antedates operation. In one of Foulds's [7] cases there were attacks of hæmaturia sixteen years before operation. In Keynes's [9] hæmaturia began six years before. Such occurrences are probably to be ascribed to infection, leucoplakia, ulceration and other predisposing causes of the carcinoma. The latter shows a very slight tendency to ulcerate deeply and this together with ureteral closure explains the occurrence of hæmaturia in only 50 per cent. of cases. Tumor implants in the lower urinary tract are said not to occur in the case of non-papillary neoplasms, and it is probable that the tumor shown in Fig. 10 was primarily papillary and at this stage gave origin to the ureteral implant shown in Fig. 9. The diagnosis of squamous-cell, or non-papillary, carcinoma of the renal pelvis would seem to have little practical importance except as the basis of a hopeless prognosis. The lament-

able truth of this is illustrated in Kretschmer's [6] series of thirty operated cases of which 53.3 per cent. died as the result of operation, and among the survivors the average length of life was seven months and fifteen days. A patient operated upon by Albarran survived four years. Four of the five cases reported from the Mayo Clinic died within three months after operation. The fifth case was apparently well six months after nephrectomy.

No one, as far as we know, has succeeded in making the correct diagnosis of non-papillary tumor of the renal pelvis, nor has anyone succeeded in recognizing the condition as neoplastic early enough to permit complete eradication of the disease by nephrectomy. Foulds [7] describes the pyelogram in one of his cases as being enlarged and irregular, but the correct diagnosis was not made. In Martin and Mertz' [13] case the tumor involved the lower portion of the true pelvis and invaded the ostium of the lower calix, but the pyelogram either did not disclose the defect, or the latter, if present, was overlooked since the diagnosis of infected hydronephrosis with multiple calculi was made. It is altogether likely that the pyelogram would disclose pelvic distortion, effacement of an involved calix, or other changes caused by an. infiltrating tumor even in the early stages, if the symptomatology indicating the necessity for such studies arose, or if calculus cases and chronically infected kidneys were subjected routinely to pyelographic study. That early diagnosis would lead to improvement in operative results is probable, but at the present time the results obtained by operation justify the conclusion that non-papillary carcinoma of the kidney is a fatal disease.

## PAPILLARY NEOPLASMS

Of the 181 cases of primary neoplasms of the renal pelvis collected by Meltzer [3] in 1926, 144 (76.6 per cent.) were papillary in form, the majority of them being papillary carcinoma. We have no means of knowing how many of the latter group were primarily benign, but the probabilities are that a considerable number began as simple papillomata. This is indicated by the history in many instances of hæmaturia long antedating operation.

Papillary tumors as a class are less malignant than the non-papillary type, but unlike the latter, they give origin in 70 per cent. of cases to tumor implants in the ureter and bladder. The papillary tumor may exhibit extraordinary malignancy and, in rare instances, an apparently benign papilloma becomes the source of widespread, rapidly growing metastases. In most instances, however, both parenchymal invasion and metastatic dissemination occur comparatively late in the disease. Marked malignancy characterized the behavior of the growth in thirty-seven of Meltzer's [3] collected series.

Hæmaturia, often massive and sometimes painless, occurs in at least 90 per cent. of cases and is likely to occur comparatively early. The tumor shown in Fig. 2 must have been present for some time, but was the source of an initial hæmaturia only one month before operation. The hæmaturia varies in degree, but truly massive renal hæmaturia in the absence of renal enlargement is very suggestive of papillary neoplasm.

Renal colic caused by the passage of clots, which are sometimes worm-like, or by pelvic blockage due to a pedunculated growth, is a frequent symptom. Fixed, boring renal pain is highly suggestive of advanced carcinoma.

Palpable renal enlargement, with or without fixation of the kidney, when due to parenchymal involvement indicates inoperability, but it is sometimes caused by hydronephrosis, which may be primary or secondary.

Intermittent hematonephrosis is a rare occurrence and is not always due to papillary tumor.

Fortunately, gross hæmaturia is a frequent symptom of papillary neoplasms of the kidney pelvis. The only dependable means of diagnosing these new growths would seem to be urographic demonstration of pelvic distortion in the routine search for the cause of renal hæmaturia.

*Differential Diagnosis.*—It may be assumed that the clinical diagnosis of an intrapelvic neoplasm is impossible. Large renal tumors associated with gross hæmaturia are usually hypernephromata, but both the recognition of neoplasm as the cause of renal symptoms and the differentiation between the various types of renal new growths are largely dependent upon urography. The differential diagnosis between papillary tumors, essential hæmaturia, early renal tuberculosis, bleeding nephritis, angiomata, hydronephrosis, and other bleeding lesions of the kidney, is likewise dependent largely upon pyelography. The clinical history, physical findings, examination of the divided urine, differential renal functional studies, and various laboratory tests are useful diagnostic adjuncts. Parmenter [14] has again called attention to the occasional presence in the urine, especially in the case of papillary growths, of tumor cells, but the method has little practical value.

Little can be accomplished in the diagnosis of renal lesions when the kidney is closed and the bladder free from pathology. The presence of a papillary growth in the bladder associated with unilateral hæmaturia, or closed kidney, should suggest the probability of a primary papillary growth in the kidney pelvis. Whenever possible, the upper urinary tract should be studied when papillary tumors are found in the urinary bladder, and ureterography is definitely indicated, especially in the case of the closed kidney, when this occurs in association with a vesical neoplasm.

The most important group of cases from the diagnostic standpoint comprises those with renal hæmaturia in the absence of renal enlargement or vesical implants. The presence of infection, or stone, does not remove the possibility of papillary tumor which is complicated by stone in 7 per cent. of cases, and often by simple infection. Massive hæmorrhage from a stone-bearing kidney is always suggestive of a complicating neoplasm. In rare instances, renal tuberculosis causes intermittent gross hæmaturia, the attacks being separated by many years. In such cases the infection often fails to show the usual tendency to involve the lower urinary tract. We recently removed a tuberculous kidney from a man who had an initial hæmaturia thirteen years before operation, a second attack eight years before. Following the second attack, we examined the patient but failed to recognize the

condition. The examination was thorough except that pyelography was omitted. The divided renal function was normal, and guinea-pig inoculations proved negative. We suspected tuberculous infection of the kidney but could not demonstrate it. Several months ago, this patient returned with a third attack of hæmaturia. Examination disclosed the presence of a normal bladder and a functionless left kidney. Tubercle bacilli were found in the bladder urine. The pyelographic medium failed to enter the kidney pelvis, but we succeeded in demonstrating the presence of a stricture at the uretero-pelvic junction. The kidney at operation was found to have a reduplicated pelvis, the upper half being hydronephrotic, the lower half tuberculous. In the event of failure to find the tubercle bacilli in this case, the diagnosis of papilloma of the kidney with carcinomatous transformation would not have been illogical.

In very early cases of renal tuberculosis with gross hæmaturia, insignificant pyuria, a normal bladder and no demonstrable tubercle bacilluria, the differentiation from papillary neoplasms is almost wholly dependent upon the demonstration of cavitation in the apices of the pyramids. Contrary to the accepted opinion, we have found little renal dysfunction measurable by the dye tests in very early renal tuberculosis.

Papillary tumors of the renal pelvis may or may not cause diminution in the function of the involved kidney, and the kidney which bleeds without evident cause, the so-called essential hæmaturia, may or may not show dysfunction, so that in the differentiation of these conditions, pyelography, while not infallible, is of paramount importance.

*Pyelography.*—The mechanics of neoplastic distortion of the renal pelvis comprise, chiefly, pressure from without, traction on the calices, distention and distortion due to neoplastic pressure and ulceration from within, dilatation of part or all of the pelvis due to urinary obstruction offered by the tumor, and various degrees of obliteration of the pelvis by neoplasms originating either within the pelvis, or invading this cavity from without. Parenchymal tumors, especially the hypernephromata, which are more or less encapsulated, usually cause pressure deformities of the true pelvis long before actual invasion of this cavity occurs, and cause at the same time elongation and narrowing of the calices through traction and pressure. The resulting spider-leg deformity is the most characteristic urographic picture caused by a renal neoplasm.

In some instances parenchymal neoplasms, especially the rare tubular carcinomata, also hypernephromata originating in the medullary portion of the kidney, cause early obliterations of one or more calices, and, through early invasion of the true pelvis, cause filling defects which cannot be differentiated in the pyelogram from those caused by primary intrapelvic growths.

It would seem to be impossible for a parenchymal neoplasm to cause the uniform distention of a calix shown in Fig. 17; deformities like this are usually caused by pressure from within.

Neoplastic foreign bodies such as large invisible stones, or blood clots,

may cause filling defects which cannot be distinguished from those caused by intrapelvic tumors, and, as mentioned above, no one has made the urographic differentiation between papillary and non-papillary new growths.

In view of the difficulties encountered generally in pyelographic interpretation one might expect some limitations in the diagnostic value of the method in the case of intrapelvic tumors. We cannot agree with Young and Waters,[15] however, who hold that with the exception of pyelography in the case of hypernephromata, efforts to distinguish the different types of tumor are useless since there are no dependable criteria, although a study of the reported cases would seem to justify their conclusion. Prior to March, 1924, only five cases of intrapelvic tumor were subjected to pyelographic study.[11] Since that time, however, papillary tumors have been correctly diagnosed by Meltzer,[3] Angle,[16] Kretschmer,[17] Graves and Templeton,[18] Day,[2] Bothe,[19] Thomas and Regnier,[11] Scholl,[20] and others.

Seely[21] reports a case of papillary tumor in which the pyelogram was normal, and states that "pyelography has not proved useful". In one of Thomas and Regnier's[11] cases the pyelogram made four years before operation was normal, and Bugbee[22] succeeding in demonstrating a filling defect some months after an initial pyelogram failed to show distortion of the pelvis. In another of Thomas and Regnier's[11] cases, bilateral pyelograms made five months before operation were negative. These cases illustrate the great folly of making the diagnosis of essential hæmaturia on the basis of an initial normal pyelogram.

Kretschmer[17] reports misinterpretation of a filling defect in the pyelogram in a case in which operation failed to disclose a neoplasm.

In some instances pyelographic misinterpretation has been due to associated stone shadows, while in several reported cases a papillary growth contained in a hydronephrotic sac failed to reveal itself as a filling defect.

Notwithstanding the difficulties and uncertainties of urographic interpretation, we agree with Braasch[23] that in the majority of cases the diagnosis of intrapelvic tumors can be made quite certain by means of pyelography. With increased experience the recognition of defects caused by these neoplasms will be made more frequently and with far greater certainty. There are no characteristic deformities demonstrable in the case of intrapelvic tumors comparable with those caused by hydronephroma, but in the majority of cases one finds an irregular filling defect of the true pelvis associated with dilatation of some of the calices and usually those situated at the upper pole. (Fig. 6.) There may or may not be obliteration of certain calices or regular distention due to pressure from a neoplasm originating within the calix, but the elongation and narrowing of one or more calices with effacement of the terminal cupping so characteristic of hypernephromata is never caused by primary growths of the renal pelvis.

Moderate-sized papillomata situated in a capacious pelvis at a point removed from the ostia of the calices and ureter cause only a circumscribed filling defect comparable in size with that of the tumor.

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Tumors originating from the pelvic walls near the ostium of a calix may cause dilatation or obliteration of the cavity of the calix. The tumor if situated at the uretero-junction causes hydronephrosis, but a filling defect representative of the tumor is often demonstrable.

Large papillary growths may fill the true pelvis and calices almost completely, the small remaining space between the tumor masses being represented in the pyelogram by small, irregular patches and streaks.

Figures like the foregoing are seldom caused by lesions other than papillary growths of the renal pelvis.

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# PRIMARY EPITHELIOMA OF THE VULVA

## AN ANALYSIS OF SEVENTY-ONE CASES *

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MUCH has been written on this subject, but most of what has been written consists of single case reports or analyses of collected cases from the literature with inadequate data. Morgagni, 1751, reported the first case of epithelioma of the vulva. Mayer, 1866, presented the first clinically significant work on the subject in a report of eight cases. Dittrick, 1905, reviewed 135 cases, specimens from seventy-three of which were studied histologically. Teller, 1907–1908, reported thirty-nine cases from one clinic, but the clinical data seem incomplete inasmuch as less than half of the cases were traced. Rothschild, 1912, reviewed 331 reported cases of malignant growths of the vulva; in thirty-nine of these the pathologic histology of the glands was studied.

Histologic study was made in all of the cases in my series and all of the patients except six were traced by follow-up letters; the information was obtained from the patient, the home physician, a relative, or from the records of The Mayo Clinic. Of the six patients who were not traced, four left the clinic with lymphatic involvement. The home physician of one reported that there was no evidence of recurrence three years and eight months after the operation. Thirty-one of the seventy-one cases have been reported by Broders in connection with epithelioma of the genito-urinary tract.

Compared with the frequency of carcinoma of the internal genital organs in women, primary epithelioma of the vulva is rare. According to Schwarz the incidence was 1.38. Virchow reported an incidence of 1.35 or 1.40. Gurlt gave the incidence of 1.48, and Taussig as 1.20. According to Brady, statistics from Johns Hopkins Hospital show nineteen cases of epithelioma of the vulva to 756 cases of carcinoma of the cervix, or a ratio of 1.39.7; however, two of the nineteen cases were epithelioma of the urethra. In The Mayo Clinic the ratio based on histologic study was 1.25.

The disease is distinctly one of advanced life, the patients as a rule being women who have reached the late sixties or seventies and even eighties. Youth, however, is not exempt. The oldest patient of whom we have any record is in a case reported by Dittrick in which the diagnosis was made at the age of ninety.

On the other hand, West, Schwarz, Lutzenberger, Merz, Björkquist and Fritsch reported cases in which this condition was observed in the second

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and third decades of life. Indeed, Le Fleur and Loörich claimed to have seen several cases in which the diagnosis was made in the first decade and Biextrix, who reported the case of the youngest patient on record, placed the early age limit at eighteen months. However, the authenticity of these cases cannot be accepted without reservation, inasmuch as the diagnosis of cases reported was not always fortified by histologic examination. Dittrick found the greatest frequency in the seventh decade; so also had Teller, Schwarz, Backer, Rothschild and Goldschmidt. Winckel, in a series of fifty-four cases, noted the greatest frequency in the sixth decade.

In the series studied here the cases were divided as follows:

| Age, years | Number of cases | Per cent. |
|---|---|---|
| 21 to 30 | 1 | 1.40 |
| 31 to 40 | 7 | 9.85 |
| 41 to 50 | 12 | 16.89 |
| 51 to 60 | 20 | 28.06 |
| 61 to 70 | 19 | 26.75 |
| 71 to 80 | 10 | 14.08 |
| 81 to 90 | 2 | 2.81 |

The youngest patient was twenty-seven and the oldest, eighty-six.

*Diagnosis.*—Early diagnosis is of paramount importance. Patients have symptoms early, but apparently from false modesty they do not seek medical aid until late. In this series, the average duration of the actual lesion before the patient came to the clinic was one and forty-nine hundredths years. In nine cases the lesions were inoperable, and four of these patients had not consulted a physician.

The differential diagnosis of primary epithelioma of the vulva and metastatic growth is of vital importance. Metastasis to the vulva is always possible and is not infrequent in cases of primary malignant growth of the ovary, fundus, cervix, vagina, and urethra. A thorough general examination, therefore, is most important. In the early diagnosis tuberculosis and syphilis are next to be eliminated. One patient in the present series was treated first for syphilis, later for tuberculosis, and finally the condition was diagnosed as epithelioma and was inoperable.

In tuberculosis or lupus the disease tends to heal with cicatrization as the ulcer advances, and often with considerable hypertrophy of the surrounding tissue. Tuberculosis occurs in younger patients and the lesion does not have as great a tendency as epithelioma to bleed on manipulation.

When the epithelioma is in the stage of ulceration it may be confused, especially with chancre, with the secondary or tertiary lesions of syphilis, and with chancroid (soft chancre).

Chancre is distinguished by the peculiar type of ulceration, by the brownish color and by the definite regularity and circular arrangement. The ulceration is rapid, not painful, and does not show a tendency to spread. The lymphatics are involved early. The soft chancre or chancroid does not resemble very much the ulceration of true carcinoma. It differs by its premature appear-

ance and rapid evolution. The lymph nodes suppurate almost from the first. The lesion has a sharp, punched-out appearance with undermined edges. When inflamed, the venereal wart can scarcely be distinguished from epithelioma. Secondary and tertiary syphilitic lesions which sometimes localize in this region are multiple and in their large variety rarely have the true appearance of a tumor. The Wassermann reaction is an aid to diagnosis.

Condylomas may be mistaken for epithelioma, but absence of pain and ulceration is important. They may bleed easily if inflamed. Usually, evidence of gonococcal infection can be found.

Urethral caruncle may simulate malignancy, but it is never indurated and it arises definitely from the mucous membrane of the urethra.

With chronic infection of the Bartholin glands there may be a tumor or cyst. There is usually a history of preceding abscess, and the tumor gradually gets smaller, is freely movable in the tissues, and is not hard.

In leukoplakia the growth is slow. There is constant absence of adenopathy; however, sometimes there is transformation of this lesion into epithelioma. When there is a nonulcerated tumor, one thinks of a simple



Fig. 1.—Epithelioma of the right labia majora.

papilloma; however, at the beginning the epithelioma has a similar appearance. The difference lies in that the papilloma does not rest on an indurated base and has more or less tendency to pedunculate. In any case of the slightest doubt it is always expedient to do a biopsy.

*Etiology.*—In speaking of the etiology, the cause of cancer in general will not be considered, but only those conditions which are commonly believed to predispose to its appearance on the vulva. The principal factors, as usually given, are mechanical injuries and the various forms of chronic irritation.

When one compares the frequency of trauma to which the external genitals of the female are subjected at childbirth and coitus with the rarity of epithelioma of the vulva, it readily appears that trauma plays only a minor part in the cause. Lutzenberger, in his series of 105 cases, noted that nineteen women were either nulliparas or virgins. Goldschmidt, in a series of

214 cases, noted that nineteen were nulliparas and six were virgins. In fifteen cases reported by Taussig six patients had not had children and three had never been married. In the present series, three patients were single, three had never been pregnant, and five had not had children; in five instances the number of pregnancies and children was not stated.

Trauma is emphasized in the literature as a cause of this condition, but it would seem that this impression is gained largely by the report of a small group of cases, which has become notorious by mere repetition, rather than by the frequency of occurrence.

In my series there was a definite history of trauma in only one case. In this case the patient, while plowing, was thrown against the edge of the seat, bruising and breaking the skin of the vulva. Instead of healing, the lesion increased in extent and bleeding and pruritus soon followed. Even in this case the patient complained of pruritus for seven years preceding the trauma.
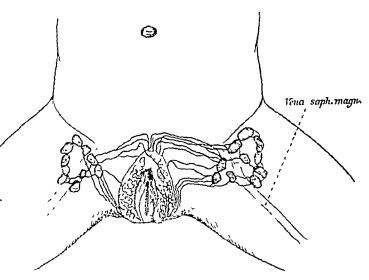
Other conditions are concerned in the lowering of local resistance and in the maintenance of chronic irritation. The most common of these is pruritus. The question whether this is an initial symptom or an etiologic factor is not yet settled. It would seem in those cases in which the patient has suffered for several years from pruritus that has caused considerable excoriation, abrasion and resultant pigmentation, and in which epithelioma has developed later, that it is only fair to suppose that the pruritus was at least an indirect factor in the production of the epithelioma. On the other hand, in those instances in which the irritation has preceded the tumor by a few months only, it should probably be regarded merely as an early symptom. Practically every writer on this subject regards pruritus as a precancerous condition. Veit knew of it and wrote that great value must be attached to the complaint of pruritus. Franke believes that either the senile or diabetic form of pruritus may be followed by epithelioma. Frankl believes there is no doubt but that pruritus may be considered in causal relationship. Rothchild believes it is likely that epithelioma develops on the base of the pruritus, for pruritus is often well advanced when there



Fig. 2.—A peri-ureteral epithelioma.

is no sign of the epithelioma. Goldschmidt considers pruritus to be symptomatic in 32.4 per cent. of his cases. Schwarz observed it ten times in his series of twenty-three cases of epithelioma of the vulva. In the series at Johns Hopkins Hospital it was present in 50 per cent. of the cases. In my series twenty-nine of the seventy-one patients gave a history of preëxisting pruritus as follows: One for twenty-five years, four for twenty years, two for sixteen years, one for fifteen years, one for thirteen years, two for nine years, one for seven years, four for three to four years, six for one to two years, four for six months before the appearance of the growth, and three for no definite time stated; one of these specified for "many years".

Whether pruritus is an etiologic factor or merely an early symptom, intense and obstinate itching is frequently the forerunner of malignancy and whenever such a symptom is present a thorough examination should be made.

In most essays on the subject some mention is made of leukoplakia in this connection. Leukoplakia is a chronic inflammation characterized by



Fig. 3.—The direction of the collecting trunks of the lymphatic network of the vulva (Bruhns).

whitish plaques rather than by a general atrophic process involving the entire vulva. Mention is made of kraurosis in the same fashion. Veit and Szasz believe that the two are identical. Histologically the lesions in leukoplakia are in the epidermis. About the first one to refer to leukoplakia as an etiologic factor in epithelioma was Bex, who in 1887 wrote that leukoplakia of the vulva and vagina are potentially epithelioma. Mayer has demonstrated a case in which epithelioma began in the epithelial thickening in the centre of one of these patches of leukoplakia. Schwarz reported a case in which an epithelioma developed on the site where one year previously he had noted a leukoplakial patch about three centimetres in diameter. In the present series leukoplakia alone existed in one case. In another case leukoplakia and kraurosis both appeared, and in three cases kraurosis alone was present. Because epithelioma has been known to develop on areas of leukoplakia, these areas should be watched carefully and with prophylaxis in mind, or on the first suggestion of malignancy they should be widely excised.

One must also consider the origin of epithelioma on benign growths, such as warts, atheromas and papillomas. Of the papillomas two were reported by Horn, two by Basset, and one by Winckel. In the present series epithelioma was found to have its origin at the site of a mole.

It is probably significant that, of the seventy-one patients in this series,

sixty-two were beyond the age of menopause which may be considered as forty-seven years. Another patient had experienced artificial menopause following total hysterectomy for uterine myomas. What the absence of the ovarian secretion has to do with malignant conditions of the external genitals is speculative.

In twelve instances there was a history of malignancy in the immediate family, affecting parents, brothers, or sisters, and in one instance, the grandmother. In one instance, according to the home physician who had taken care of all of them except one, three sisters of four had malignant growths of the vulva and their father had died from cancer.

*Signs and Symptoms.*—Epithelioma of the vulva may exist for some time without causing any symptom, and often the tumor is discovered only accidentally.

Twenty-nine patients complained of pruritus, and this to them was the first indication of the disease.



Fig 4 —Lymphatics of the clitoris (Cunéo and Marcille).

The next most frequent sign of the disease is the new growth itself with its ulcerating tumefaction and hardness.

Pain is a late symptom. As long as the tumor has not broken through and ulcerated, pain does not seem to be present. The pain increases in severity as ulceration advances. It is described as sharp, piercing, darting, pricking, lancinating, stinging, smarting or burning, and comes on in paroxysms which are worse at night. It frequently radiates into the hip and down the thighs, or it may be referred to the lower part of the abdomen or the vagina. Walking, or even sitting, is soon accompanied by great distress and the patient becomes bedridden. As soon as there is ulceration there is a discharge, at first merely from the mechanical irritation of the tumor. As a rule the patient does not seek medical assistance until there is ulceration. Thirty-four of the patients had ulceration when first examined. As time goes on the discharge becomes more profuse. At first it is whitish, mucoid and watery, but later, as the tissue degenerates, it becomes fetid, yellowish, and purulent. It is tinged with blood from time to time, but seldom is there profuse hæmorrhage. Hæmorrhage was one of the complaints in eleven instances. Painful coitus was the first complaint in one case. Urination is often interfered with, especially in cases in which the growth is at the clitoris or is peri-urethral. The urine trickles over the

ulcerated surface and causes smarting, burning and scalding pain on voiding. In many cases there is frequency. Urinary incontinence and difficult micturition may also follow as a result of the infiltration of the surrounding tissue by the new growth. Often the first sign of the disease is the presence of metastatic nodules and symptoms arising from these.

Secondary anæmia and cachexia are progressive with the course of the disease. There is much loss of strength, failure of appetite, the patient gets no rest, and death comes from exhaustion. Other complications which can cause death are involvement of the bladder, resulting in cystitis and ascending urinary infection, phlebitis, thrombosis of femoral vessels with resulting lymphedema of the legs, chronic septicæmia and, rarely, frank hæmorrhage. In the present series three patients died from extensive lymphedema of one of the legs. Usually the end comes from progressive failure and exhaustion before the foregoing complications set in.

*Associated Lesions.*—
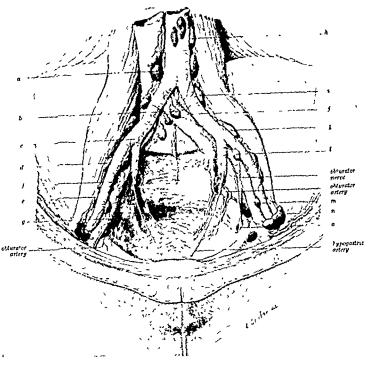


FIG. 5.—The iliopelvic glands (Cunéo and Marcille).

In this connection there is probably not much to be said. Mention already had been made of pruritus, leukoplakia, kraurosis and benign growths such as warts, atheromas and papillomas.

Two patients had had syphilis long before the epithelioma of the vulva appeared. In one of these cases there was also a history of gonorrhœal infection followed by venereal warts.

Diabetes mellitus was observed in two other cases. In one case the disease was of seven years' standing and was associated with pruritus of the vulva. In the other case the diabetes was accompanied by vascular changes, was of shorter duration and was not associated with pruritus. One patient had pin-worm infection of two years' duration associated with severe pruritus of the vulva and anus. It would appear, therefore, that the abnormal associated conditions are relatively insignificant and are not characteristic of the disease, but rather are the same conditions one would expect to observe with equal frequency in a group of women in the later decades of life.

*Anatomy of the Lymphatics.*—In view of the important part played by the lymphatics of the vulva in the spread of carcinoma a brief sketch of the anatomy of the lymphatics is presented.

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The oldest significant work on the lymphatics was done by Sappy in 1874 working with mercury injections. This work was continued by his pupil, Poirier, who, in 1892, advocated injection of Prussian blue, adopting Grotas' process. Working with Poirier were Cunéo and Delamere, the latter primarily an histologist. Together they again undertook the study of the lymphatics of the entire body. Their work on the lymphatics of the vulva was an authoritative contribution and more recently has been confirmed by Cunéo and Marcille and Bruhns and may be presented as follows:

The lymphatics of the vulva arise from a network, the extremely close meshes of which are superimposed in several planes. This network covers the fourchette, the urinary meatus, the vestibule, the prepuce of the clitoris, the clitoris, the labia minora and the internal surface of the labia majora. It is so loose and close throughout that when it has been well injected it presents at first sight merely an ashy-gray appearance. To distinguish the innumerable silvery filaments of which it is composed a magnifying glass must be used. On the external surface of the labia majora the network composed of smaller and larger branches becomes sufficiently distinct to be recognized by the naked eye.

From the periphery of this network of origin run the collecting trunks. The direction of these trunks varies according to their points of origin. Those which come from the anterior third of the vulva run directly upward and forward toward the mons veneris; there they turn sharply and run transversely toward the superficial inguinal lymph nodes. The trunks which come from the posterior two-thirds are directed upward and outward and directly reach their terminal nodes.



Fig 6.—Epithelioma, graded 1 (x 75).

The inguinal nodes consist of two groups: the superficial and the deep. The superficial are found in the deep layers of the superficial fascia. The number varies from ten to twenty. For convenience they are grouped into superior internal, superior external, inferior internal and inferior external groups.

The majority of the lymphatics of the vulva terminate in the nodes of the superior-internal group. Some of them may end in the inferior-internal group. It is even possible, although much more rare, for some of these vessels to reach a node belonging to one of the two external groups.

When injecting one-half of the vulva, the mass may frequently be seen to reach the nodes of the opposite side. Participation of those nodes in the injection may take place by a double process. Sometimes it is effected by continuity in the median line of the network of origin of the two sides of the vulva; at other times it is due to the fact that some of the collecting trunks cross the median line and end in the inguinal region of the opposite side.

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The lymphatics of the clitoris deserve special mention. In fact, although the lymphatics of the prepuce of the clitoris pass into the superficial inguinal nodes, like the other lymphatics of the vulva, this is not the destination of the lymphatics of the glans of the clitoris. The latter lymphatics are in general arranged identically with those of the lymphatics of the glans in the male. The network of origin gives rise to several collecting trunks which run on the dorsal surface of the clitoris and reach the front of the symphysis; they anastomose at this point and form a parasymphysial network in which some small nodes may be seen. From this plexus run two sets of collecting trunks. One of these vessels runs in the inguinal canal and ends in the external retrocrural node. This vessel usually is placed beneath the round ligament

and may show in its course a small interrupting glandular nodule. Other trunks run toward the crural canal and end in a deep inguinal node, in the gland of Cloquet, and in the internal retrocrural node.

The research on the lymphatic vessels of the Bartholin glands presented a hard problem. The results are not absolutely true and unquestionable. Bruhns always found only injection of the inguinal nodes, and the lymph channels never led to the pelvic nodes. The trunks leading to the inguinal nodes corresponded with those seen during the injection into the labia.

Attention is called to the fact that the network of lymphatics of the vulva, which is tributary to the inguinal nodes, is distinctly separated by the hymen from the vagi-



Fig. 7.—Epithelioma, graded 2 (x 75).

nal lymphatic plexus, which is tributary to the pelvic nodes. This separation is especially marked in children in whom vaginal lymphatics do not terminate in the inguinal nodes. As shown by Poirier, and later by Bruhns, injections within the hymenal septum in children pass to the lymph vessels going to the pelvic nodes; whereas, injections applied on the septum next to the vulva reach the lymph vessels going to the inguinal nodes. In adult women it is possible for injections made at the level of the lower portion of the vagina to reach the inguinal nodes, not through direct collecting channels, but by way of numerous anastomoses which unite the network of the vagina with the network of the vulva.

Involvement of the lymph nodes in the tissue surrounding the rectum seems probable, but has not as yet been established positively.

The efferent vessels of the superficial inguinal nodes end in the deep inguinal or in the external iliac nodes. The efferent vessels which terminate in the deep inguinal nodes are the least numerous. They come especially from the nodes of the two lower groups. The efferent vessels which terminate in the pelvis are much more important; they vary in number from eight to twelve and are always of considerable calibre.

The deep inguinal nodes are less important than the superficial nodes. They vary in number from one to three and usually are not large. They are continuous above with the internal chain of the external iliac nodes. The superior node of the group occupies the external part of the crural canal and protrudes through the crural septum into the pelvic cavity. French writers call it the gland of Cloquet, whereas German writers call it the gland of Rosenmüller.

Aside from receiving some of the efferent vessels from the superficial inguinal nodes, the deep inguinal nodes receive efferent vessels, also from the deep lymphatics which accompany the femoral vessels. The efferent vessels of these nodes penetrate into the pelvic cavity and almost all terminate in the internal and external retrocrural nodes.

Although the lymphatic nodes of the pelvis are continuous, without line of demarcation from the abdominal nodes, they are divided for convenience into two groups. These groups are separated by an imaginary horizontal line passing through the bifurcation of the aorta, into an inferior or iliopelvic group and a superior or abdomino-aortic group.

The iliopelvic nodes have a paravascular arrangement enabling them to be divided into three groups, namely the external iliac, the hypogastric, and the common iliac.

The external iliac nodes grouped about the external iliac vessels are regarded as forming three chains more or less continuous, external,



FIG. 8.—Epithelioma, graded 3 (x 75).

middle and internal. The lowest node in each chain is called retrocrural. The external iliac chains receive lymphatics coming from the inguinal nodes. The external and internal chains receive these vessels directly. The middle chain receives them only after they have been interrupted in the external and internal retrocrural nodes.

Each node belonging to these different chains sends its efferents to the node above it, so that the highest node of the chain continues the lymphatic circulation of those placed below it. Ultimately they terminate in the nodes of the common iliac group.

The internal iliac or lymphatic nodes receive efferents from all the pelvic viscera. The efferent vessels terminate in the middle part of the common iliac nodes.

The common iliac nodes, grouped around the common iliac artery, also are divided into external, middle, and internal groups. The internal group lies in front of the body of the fifth lumbar vertebra or on the disk between this and the sacrum and is sometimes called the group of the promontory. The external and middle group do not receive any vessels emanating directly from the neighboring organs. On the contrary they form the terminus for the numerous and large efferents of the external iliac and internal iliac lymphatic nodes. The internal group receives vessels from most of the pelvic

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organs. The efferents of the three groups converge toward the inferior part of the lateral aortic chain of the corresponding side. All the iliopelvic lymphatics finally end, therefore, in the two right and left juxta-aortic chains.

The practical application of the anatomic data is clearly and concisely summarized by Crossen as follows:

1. From carcinoma of the labia majora or minora all the lymphatic distribution in the early stage is likely to be to the inguinal nodes.

2. This distribution may extend not only to the side on which the lesion is situated but also to the opposite side; hence the nodes on both sides should be removed.

3. In carcinoma of the clitoris early distribution to the glands inside the pelvis is probable.

*Metastasis.*— Metastasis is often noted in the neighboring areas of the vulva or even in the perineum. The infective material is carried through the lymphatics, although when metastasis is in the perineum the cells have travelled against the lymphatic current. Taussig recorded a case of peri-urethral epithelioma with implantation metastasis in the left gluteal region. In the present series in one case there was perineal infiltration with loss of rectal sphinc-


FIG. 9.—Epithelioma, graded 3 (x 325).

ter control. In another case there were two superficial implants on the left buttock, a short distance from the anus.

Involvement of the adjacent skin and mucosa of the opposite labium results in the so-called contact epithelioma. Cases of this nature have been cited by Schwarz, Hildebrandt, Zweifel, and Kelly. In the present series a malignant new growth on the opposite labium was noted in three cases on first examination. In two other cases contact growths were noted on the second examination, one six months, and the other eight years following the previous operation. In the latter case, it is likely that the second lesion was a new and independent growth and not recurrence. Franke pointed out that the origin of these contact growths is due to the invasion of the carcinoma through the blood or lymphatic vessels, mechanical irritation of the tumor itself, lowering of the local resistance from the secretion of the ulcerated tumor, direct transplantation of masses of cells, and the implantation of the organisms if there are organisms in the carcinoma.

Special importance is attached to early involvement of the regional lymphatics. Involvement of the external inguinal nodes represents the first stage; of the deep inguinal nodes, the second stage; and of the external iliac; hypogastric and common iliac nodes, the third stage of carcinomatous invasion. The inguinal nodes may or may not be enlarged. If they are enlarged it is due to hyperplasia or malignant involvement. Lymphatic hypertrophy is usually early in cases in which the primary tumor shows early ulceration. The differential diagnosis is not reliable except that made by extirpation and microscopic study; and even by the latter method one can study sections which may be negative for malignant cells, and yet in certain parts of the nodes there may be malignant cells.

Dittrick, in a review of 135 cases, found that in thirty-three cases, clinically there was involvement of the nodes, and in seven of these the diagnosis was confirmed by microscopic examination. In thirty-six additional cases the nodes were enlarged, but in twelve of these the condition was due to hyperplasia of the lymphoid tissue without any carcinomatous invasion. In several cases there was slight enlargement of the nodes before excision of the ulcerated tumor, and with the removal of the growth swelling of the nodes subsided.

Schwarz, in twenty-three cases, noted glandular hypertrophy in eleven cases; in twelve, none. In the eleven cases, extirpation and microscopic study disclosed malignant involvement in five cases and inflammatory hyperplasia in the remaining six.

In the cases reviewed by Rothschild a microscopic study of the nodes was made (Table I).

TABLE I.

*Results of Microscopic Study of Lymph Nodes in Thirty-nine Cases of Primary Carcinoma of the Vulva*

| | Cases | Carcinomatous | | Noncarcinomatous | |
|---|---|---|---|---|---|
| | | Cases | Per cent | Cases | Per cent |
| Microscopically enlarged............. | 32 | 15 | 46.9 | 17 | 53.1 |
| Questionable whether enlarged or not | 3 | 2 | 66.6 | 1 | 33.3 |
| Not enlarged..................... | 4 | 2 | 50.0 | 2 | 50.0 |
| Total........................ | 39 | | | | |

Schultze, in a review of 114 cases, found that the infiltrated nodes from twenty-one cases were studied microscopically. Of these cases malignant involvement was found in ten and was not found in eleven.

In my series of cases the clinician reported enlarged inguinal nodes in thirty cases. Nine of these were inoperable. In three others nodes were not removed. In the remaining eighteen cases the nodes were removed at the first operation. Carcinoma was found in fourteen of the cases. Nodes were also removed in fifteen other cases at the first operation, but in these there

was no hypertrophy. Carcinoma was found in only three of the fifteen cases. The clinician had noted that nodes were not enlarged in two of these three cases. In the third case mention of nodes was not made.

Through the communication of the inguinal with the iliopelvic nodes, metastasis to these nodes is easily possible. In the present series pelvic involvement was evident in four cases, and in another case there was a large retroperitoneal mass and recurrence when the patient returned following operation.

In its continued development, the carcinoma encroaches on the pelvic connective tissue, especially on the retrovaginal and vesicovaginal septum.

The pelvic bones, more particularly the descending pubic rami, may become diseased and cancerous, as seen in one case of this series. In two other cases metastatic extension occurred over the suprapubic area.

Schwarz found metastasis in the brain and dura. In one case in the present series there was associated carcinoma of the third cervical vertebra, diagnosed by röntgenogram. This was considered metastatic. Two months prior to death the patient could not move



Fig. 10.—Epithelioma, graded 4 (x 75).

his head and he suffered from severe pain. Küstner recorded a case of carcinomatosis of the lung with carcinoma of the heart, liver, spleen, and kidney. Carcinomatous nodules were found by Arnott in the pleura, in both lungs, and in the heart; the primary seat of the neoplasm was the clitoris. Franke, from the clinical symptoms, diagnosed metastasis in the lung in one case. In the present series extensive infiltration of the lung developed in three cases. In another case the patient died two and a half years following local excision of a six-months' growth. According to the daughter of the patient, there were no signs of recurrence, but death had been caused by a relapsing type of pneumonia.

There were three post-operative hospital deaths: one was due to bronchopneumonia and purulent pericarditis; one, to erysipelas and septicæmia; and the third, to extensive cellulitis. Post-mortem examination was made in

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two of the cases, but metastasis was not found. In both cases extensive operations with lymphatic dissection had been done, but the nodes were not involved.

The primary growth in all cases was definitely on the vulva. The structures of the vulva which were first involved and the number of cases that represent each type of involvement were as follows: right labium majus, thirty; left labium majus, twenty-seven; right labium minus, one; left labium minus, three; clitoris, four; anterior commissure, two; posterior commissure, one; Bartholin's gland (one right and one left), two; peri-urethral structures, one. The point of origin is as frequently on the left side as on the right. This is not in agreement with most writers who claim to have found a much higher frequency on the right. Thus Lutzenberger, 1894, in his review of 105 cases, gave the following apportionment: right labium majus in forty-five cases, left labium majus in fourteen, labia minora, in sixteen, clitoris in twenty, commissure in eight, and peri-urethral structures in two.



FIG 11 —Epithelioma, graded 4 (x 350).

In the beginning the disease occurs usually as induration of the dermis, a papule, a vesicle, or a nodule. Sometimes there appears a crack or fissure. Sometimes the clitoris is enlarged or a Bartholin gland is present. Later, when the disease is further advanced, there are two types: the prominent tumor, and the ulcerating type. Ulceration may be present as early as three weeks after the tumor has been noticed, or there may not be ulceration for a much longer time. After this change has taken place the surface becomes more irregular, raw and granular in appearance. In the crypts collections of pus and débris can be seen. In consistence it is firm, except where there is much necrosis, then soft areas are present. The tumor oozes blood readily on manipulation and is friable. On section it is pearly white, with small yellowish areas of necrosis which can be squeezed out on pressure. At first the tumor is superficial; later, epithelial cords are felt extending into the deeper tissues. The base is hard and indurated.

In the present series there was tumefaction in only thirty-seven cases, whereas in thirty-four there was ulceration or both tumefaction and ulceration.

Exact dimensions of the lesions were obtained in most cases, but to obtain them in all was not possible, especially if the cautery had been used. In these latter cases only approximate sizes were secured, which were divided, from the surgeons' descriptions, into small, medium and large. The lesions in which exact dimensions were obtained also were divided into three groups. If the greatest diameter of the lesion were two centimetres or less, it was considered small; if it were two to four centimetres, it was considered medium, and if it were more than four centimetres it was considered large. Thus a combination of exact and approximate dimensions of practically all lesions was secured. In twelve cases they were small, in twenty-two, medium, and in thirty-one they were large. In six cases the size was not stated, but in five of these the lymph nodes were found to be involved. From this it may be concluded that the lesions probably were large, or at least of medium size.

Microscopic study was made in every case. The tumors of the Bartholin gland were adenocarcinomas. All of the other growths were squamous-cell epitheliomas. Malignancy was graded on a basis of one to four according to the method of Broders, absolutely independently of the clinical history. The results were as follows: grade one, three cases; grade two, forty-five cases; grade three, seventeen cases; grade four, six cases; total, seventy-one cases. Thus most of the growths were graded two, approaching grade three, rather than grade one.

*Treatment.*—The type of treatment has been much at variance. Dieffenbach and Hildebrandt first held that new growths were inoperable when the lymph nodes were swollen. Winckel considered excision of the lymph nodes a grave procedure on account of the age of the patient. He believed that excision of the growth was satisfactory. Gartner, in 1905, strongly advised removal of the inguinal nodes even though they were not enlarged, believing that probably they were enlarged and still could not be palpated on account of obesity. He further believed that they could contain malignant cells without being enlarged. Rupprecht recommended extensive dissection of all lymph nodes, superficial and deep, analogous to the operation for carcinoma of the breast. Döderlein, in 1907, thought that if lymph nodes of both sides were cleaned out alike the results would be better. Bruhns, in 1898, showed experimentally on cadavers, by injection of dyes, that involvement of the lymph nodes of the opposite side was readily possible. Basset gave perhaps the first method for dissection of the entire superficial and deep inguinal and femoral lymphatic chains. He advised the two-stage operation, doing the lymphatic excision two weeks before the excision of the tumor. It remained for Kehrer, in 1912, and Stoeckel, in 1910 and 1912, to devise methods for the removal of the pelvic lymph nodes either by extraperitoneal or intraperitoneal procedure.

The present-day treatment of epithelioma of the vulva is surgical, in

the form of wide excision not only of the growth but also of the regional lymph nodes on both sides, whether palpable or not, followed by the use of radium and Röntgen-ray. The latter is considered by Desjardins and Bowing as an aid to operation.

In cases in which the lesion is too far advanced for removal, destruction of the lesion by surgical diathermy, intensive application of radium and superficial and deep Röntgen-ray treatment, is the next best procedure. Surgical diathermy is electrocoagulation and is followed by the use of radium and Röntgen-ray. In the advanced cases radium and Röntgen-ray only are used. The great disadvantage of radium is that its effect diminishes with distance and, therefore, it is reserved for the local lesion and also for enlarged palpable lymph nodes. Röntgen-ray is employed by the superficial and deep methods. The local lesion often responds well to radium and also to the Röntgen-ray; there is much alleviation of pain and inhibition of the external growth for a time, but later the disease resumes its course.

In recurrent cases surgical procedures are again indicated first of all, provided there is anything that can be removed, but it is not the local lesion that causes death. It is the secondary lesion which ends the patient's life and usually the recurrence following an operation is not local, but lymphatic. In these cases radium and Röntgen-ray are employed in increasing doses again with much relief from pain, swelling, œdema, and with decreased amount of discharge.

In the present series the initial treatment in the seventy-one cases was as follows: Knife excision of growth in eleven; knife excision of growth immediately followed by cautery in three; cautery excision of growth in twelve; knife excision of growth and lymph nodes on the same side in eight; cautery excision of growth and knife excision of lymph nodes on the same side in five; knife excision of growth and lymph nodes on both sides in three; knife excision of growth and lymph nodes on both sides followed immediately with cautery in four; cautery excision of growth and knife excision of lymph nodes on both sides in ten; cautery excision of growth and lymph nodes on the same side in one; cautery excision of growth and lymph nodes on both sides in two; surgical diathermy (one labium) in one; surgical diathermy (both labia) in one; palliative vulvectomy in one; and no treatment because of inoperability in nine.

Besides the foregoing treatment nineteen of the patients were treated also with radium and Röntgen-ray post-operatively received. Three received radium and Röntgen-ray treatment pre-operatively as well as post-operatively. Radium alone, post-operatively, was used in eleven; whereas in three, Röntgen-ray alone was used post-operatively. In five of the inoperable cases radium and Röntgen-ray treatment only was given. In the remaining four inoperable cases treatment was not given.

The choice of treatment is governed by the particular case. The grade of epithelioma, the age of the patient, the extent of the lesion, the associated

lesions, and the patient's general condition all must be taken into considera-tion. In only three cases palpable lymph nodes were not dissected, in two cases on account of old age and debility, and in the other case on account of advanced myocardial degeneration.

The radical procedure of removing the pelvic lymph nodes seldom has been resorted to and was not followed in any of the cases in this series. It is doubtful if such radical and extensive treatment is altogether justifiable in feeble and decrepit women in the seventies and eighties, and these women represent a large percentage of the patients. Operative encroachment on the urethra, furthermore, is not justifiable.

*Results and Prognosis.*—Epithelioma of the vulva is not rapidly pro-gressive, but almost always it brings death to its victim.

Rothchild gave the following statistics from 225 cases reviewed by him:

Of the 111 patients operated on without excision of the lymph nodes there were recurrences in seventy-one (63.96 per cent.); after four to five years' observation, nine (8.11 per cent.) still were free from recurrence.

Of the eighty-four patients operated on with dissection of the lymph nodes there were recurrences in fifty-one (60.7 per cent.). After the same observation period as in the other group, eight (9.5 per cent.) still were free from recurrence.

Schultze reviewed cases, including the twenty-three cases of Schwarz, and reported the following: Fourteen patients were free from recurrence after five years' observation; six patients were free from recurrence after four years' observation, and eight patients were free from recurrence after three years' observation.

In the present series, not counting the three patients who died following operation, or the six patients who could not be traced, four of whom had lymphatic involvement at the time of operation, sixty-two patients remain for consideration. Forty-four of these are dead from carcinoma; only one had died from some other cause, namely, relapsing pneumonia two and a half years following operation. It may be that the pulmonary condition was a metastatic lesion.

The average time of life, of the forty-four patients who died from carci-noma, from the time of their first examination at the clinic to the time of death, is two and twelve-hundredths years. This average is derived from the following figures: Two patients lived nine years; one patient, eight years; three patients, six years; one patient, five years; one patient, four years; four patients, three years; seven patients, two years; five patients, one year, and twenty patients, less than one year.

Four patients are living, but have recurrences: one, after eight years; one, after seven years; one, after four years, and one in less than one year.

Thirteen patients are living and are free from recurrence. Their average time of life, from the first examination at the clinic to the present date, is seven and seventy-seven hundredths years. These patients and the time since examination are grouped as follows: Two patients lived fifteen years;

one patient, twelve years; three patients, nine years; one patient, seven years; one patient, six years; one patient, five years; one patient, three years; two patients, two years, and one patient, one year.

The duration of life from the point of view of operative procedure is as follows:

| Group | | Cases | Duration of life, years |
|---|---|---|---|
| 1 | Extirpation of the growth ............... | 26 | 3.25 |
| 2 | Extirpation of the growth and of the lymph nodes on the same side ........ | 14 | 3.64 |
| 3 | Extirpation of the growth and of the lymph nodes on both sides ........... | 15 | 5.00 |

Generally speaking, the cases in Group 1 were not as far advanced as those of Groups 2 and 3. However, of the fourteen cases that were diagnosed as recurrent, six were in the first group, three in the second, and two in the third. The remaining three cases were inoperable.

Fourteen cases in the series of seventy-one were diagnosed as recurrent, and operation had been done elsewhere. In all of these fourteen the operation that had been done elsewhere was simple excision of the growth with the knife or cautery. The tumor had been removed by surgical diathermy in one case.

Of the twenty-six patients who were operated on by extirpation of the growth, three returned later with lymphatic involvement. Seven of the group are still living, six of whom are free from recurrence.

Of the fourteen patients who were operated on by extirpation of the growth and of the lymph nodes on the same side, two returned for further treatment. One of these had lymphatic involvement of the opposite side four months after the first operation. The other returned with local recurrence, as well as with recurrence in the groin on the same side. Three of the group are living and are free from recurrence.

Of the fifteen patients who were operated on by extirpation of the growth as well as by bilateral lymphatic dissection, three returned, one of whom had a local recurrence. The other two had lesions in opposite labium. One of these had been free from recurrence for eight years and the growth for which she returned is probably an independent one; the other patient had been free from recurrence for four years. Four of the group are living and are free from recurrence.

Three of the four patients with epithelioma of the clitoris died after an average duration of life, from the time of their examination, of ninety-seven hundredths of a year. The fourth patient is living and is free from recurrence after nine years. In this patient the growth was small, was of less than six months' duration, the malignancy was graded two, and the operation consisted of wide excision of the growth and bilateral lymphatic dissection. The lymph nodes were not involved.

There were two patients with involvement of one of the Bartholin glands.

One of them lived eighty-three hundredths of a year. The lesion was of four months' duration, of medium size, the malignancy was graded three, and the operation consisted of wide excision of the tumor. The other patient is living and is free from recurrence after two and seventy-five hundredths years. The growth was of one year's duration, of medium size, the malignancy was graded two, and as in the first instance the operation consisted of excision of the tumor.

The average duration of life of all the patients in relation to the grade of malignancy (tabulation) does not include the six patients who were not traced nor the three who died soon after operation, but it does include the other sixty-two patients of the series of seventy-one and is based on the interval from the time of the first examination at the clinic to the time of death, or, if the patients are still living, to the present time.

| Grade of malignancy | Cases | Average duration of life, years |
|---|---|---|
| 1 | 3 | 5.95 |
| 2 | 37 | 4.37 |
| 3 | 16 | 1.91 |
| 4 | 6 | 1.70 |

All the patients with malignancy graded one are still alive, while those with malignancy graded four are dead. Of the other thirteen patients who are living, ten have malignancy graded two and in three it is graded three.

The grading of the malignancy and the average duration of life of the patients who have died of the disease are as follows:

| Grade of malignancy | Cases | Average duration of life, years |
|---|---|---|
| 2 | 25 | 2.79 |
| 3 | 13 | 1.04 |
| 4 | 6 | 1.70 |

## SUMMARY AND CONCLUSIONS

1. A series of seventy-one cases of primary epithelioma of the vulva, seen at The Mayo Clinic between 1907 and 1927, is reviewed.

2. Epithelioma of the vulva is a comparatively rare disease. The ratio of this disease to carcinoma of the cervix is 1.25.

3. The lesion is most common in the sixth and seventh decades. The youngest patient in the series was aged twenty-seven years and the eldest eighty-six years.

4. Trauma does not seem to hold any etiologic relationship. On the other hand, causes of chronic irritation, such as pruritus, particularly if it exists before there is any sign of a tumor, must be considered as a significant etiologic factor. Forty per cent. of the patients gave a definite history of preëxisting pruritus.

5. The most common symptom is itching. Ulceration may appear any time during the course of the disease; 47.5 per cent. of patients had ulceration when first examined. This is associated with pain, more or less dis-

charge, and at times with slight bleeding; then follows intractable insomnia, secondary anæmia, cachexia, and not infrequently urinary complaints.

6. Early diagnosis is of primary importance. Women must be taught to abandon the idea of false modesty and physicians must make a careful examination. Patients with pruritus should be particularly instructed regarding the value of repeated examination and of immediately reporting any lesion.

7. In the differential diagnosis metastatic growths, tuberculosis and syphilis must first be eliminated. If there is any doubt a biopsy should be made.

8. The local lesion may be of the superficial vegetative type or it may be of the deep infiltrative type.

9. Metastasis may occur any time during the course of the disease. The lymphatic drainage with the exception of that of the clitoris is first to the inguinal lymph nodes, usually on the same side; but drainage to the opposite side also is anatomically possible and not infrequent. The lymphatic drainage from the clitoris is usually directed into the pelvis; similarly, the inguinal lymph nodes drain directly into the pelvis.

10. The regional lymph nodes may be palpable without containing malignant cells, and conversely the nodes may contain malignant cells without being palpable. The only way to be sure whether or not they contain malignant cells is to remove them and to study them histologically.

11. Epithelioma of the vulva arises most frequently from the labia majora. The disease occurs as frequently on one side of the vulva as on the other.

12. The majority of cases is of an average grade of malignancy, grade two, approaching grade three rather than grade one, according to Broders' classification.

13. Treatment must be fitted to the individual case. Wide excision of the local growth and excision of the superficial and deep inguinal nodes on both sides, whether enlarged or not, supplemented by radium and Röntgen-ray, is the treatment of choice unless metastasis obviously has advanced beyond the point where surgical intervention can help the patient or unless the existing growth has been graded three or four.

In these cases in which the malignancy is of the graver types, three and four, it would seem wiser to excise only the local growth and supplement this by radium and Röntgen-rays applied over the site of the original growth and the lymphatic drainage.

Finally, in those cases in which there is obvious lymphatic involvement and a graver type of malignancy, graded three or four, radium and Röntgen-ray alone should constitute the treatment because in these cases the recurrence is too prompt to warrant surgical procedures.

14. Forty-five patients are dead. All of these except one died from carcinoma. The remaining seventeen patients of the series are still living. Of these, thirteen are free from recurrence after an average duration of seven and seventy-seven hundredths years. One patient had recurrence after eight years, one after four years, and one within less than a year

after operation. Therefore, the prognosis is fair for prolongation of life, but poor for cure and would seem to be in direct proportion to the grade of malignancy.

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# OSTEOMYELITIS OF THE VERTEBRÆ

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*Symptoms.*—The general symptoms and the course of acute infective osteomyelitis of the vertebræ differ in no essential particulars from those observed when the same disease attacks the bones of the limbs. The local signs, however, do present special characteristics, and these differ strikingly according to the segment of the spinal column affected.

The general clinical symptomatology of vertebral osteomyelitis may assume several different forms, according to the severity of the infection. Several clinical groups and subgroups can be differentiated because of this factor. These have been previously indicated in other publications and are repeated here for emphasis and especially because osteomyelitis of the vertebræ, more than other forms of acute osteomyelitis, illustrates these clinical subdivisions most clearly and emphatically.

1. The clinical picture of the cases in this group is that of a profound general infection—there is marked toxæmia, and there is a very severe organic reaction. The disease begins with violent chills and high fever follows; the general condition frequently and suddenly becomes very bad; the pulse becomes weak and feeble; the urine is scanty and sometimes contains albumin; diarrhœa often appears; the patient is prostrated, and is covered with perspiration. In the most severe cases death follows in a few hours from the general infection.

A local focus of osteomyelitis is either not demonstrable at all because of the paucity of local signs and symptoms, or because the latter are hidden in the profound intoxication; or if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis of the picture lies in an extreme and severe general blood infection with highly virulent organisms, in which the bacteria are rapidly being discharged into and are multiplying in the blood stream and because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The subsequent multiplication in the blood stream depends on other factors, the most important of which lie in the high virulence of the infecting organism and in the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation in the bone plays no rôle in the production of any part of the clinical picture. These are the cases in which a diagnosis is frequently impossible. They are often mistaken for typhoid fever, cerebrospinal meningitis or some unknown infection. Usually the inflammatory picture in the bone—the osteomyelitis—is not in a

very advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

2. In the cases of vertebral osteomyelitis of moderate severity an exact diagnosis can usually be made. As in all cases of osteomyelitis, there are general symptoms such as fever, chills and headache, etc., etc. Two subgroups can be distinguished:

*A.* In the first variety a focus of osteomyelitis is present with well marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteriæmia is not present. The physical basis for this variety lies (*a*) in a primary and temporary bacteriæmia; (*b*) in the development of a fixation point in a bone; and (*c*) in the subsequent spontaneous disappearance of the bacteriæmia.

*B.* In the second variety a well-marked focus of osteomyelitis is present with abundant local signs and symptoms and, in addition, there are clinical indications of a bacteriæmia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteriæmia by constantly feeding into the blood stream a comparatively small number of viable organisms. Most commonly, after efficient surgical treatment, the bacteriæmia eventually disappears and a recovery is made. It must be remembered that any of these cases may at any time pass into the first group. The possibility also exists, as mentioned in preceding publications, of the local focus of osteomyelitis in cases of this variety becoming a secondary point of distribution.

In actual disease it seems certain that the cases differentiated in each of these three groups from progressive stages each from the next preceding group. A mild case may transform itself into a severe case and, conversely, a severe case having been appropriately treated, may retrogress as it proceeds to healing and recovery. These interchanges are constantly occurring in clinical surgery. Usually when a mild case assumes clinical and laboratory characteristics of a severe case there is a continued progression until the eventual fatality. In actual practice cases in Group I must necessarily first pass through the stages indicated by Group II; the time interval may be so short, however, owing to the virulence of the infecting organism, as to be unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in Group I in this way. In many cases characteristics can be distinguished which belong to both Group I and Group II; and insofar as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations.

In actual practice the illness commences suddenly, sometimes spontaneously, at other times after an injury often slight in nature. There is malaise, local indefined or no pain, fever often accompanied by an initial rigor, and when the patient comes under observation he presents the aspect of extreme illness usually observed in an acute infection of bone. The grade of these symptoms corresponds to one or other of the groups previously made. At

an early stage a tendency to assume the supine posture is to be noted, also tenderness and rigidity of the affected portion of the spine. In a few days, especially in the cases corresponding to those in Group II, local signs commence to point to the actual seat of disease.

When the lesion is in the neural arch or in any of its processes, the signs consist in the development of an indefinitely demarcated and widespread œdematous swelling and tenderness over the appropriate part of the spine. This swelling is rarely detected before the third or fourth day, and in many of the recorded cases not before the eighth or tenth. The swelling may start centrally and spread in each direction when the spinous process or the neural arch in its immediate neighborhood is the part primarily affected, or it may be unilateral when the transverse process or lateral portion of the arch are attacked, often spreading widely over the ribs. The most striking characteristic of this group of signs is the widespread area of the soft parts affected compared with the extent of the bone disease. In a considerable number of the cases great distention of the superficial veins over the surface of the abscess has been described.

In the less severely toxic cases pain is a very important symptom. The pain is of two forms, spontaneous or provoked. The characteristics of the spontaneous pains are rather vague. The patient complains of a diffuse spinal pain which may become manifest several days or even weeks before the appearance of the infectious symptoms. In addition to the spontaneous pain there are always other painful sensations. Any movement of the spinal column increases the pain and the patients assume very strange attitudes in bed. There is also regional rigidity, which is probably due to contractures of the muscles. This is especially characteristic of osteomyelitis involving the cervical spine.

Provoked pain has a very great diagnostic value and permits localization of the process at a relatively early stage of the disease. Pressure over the affected region produces very severe pain.

In a short time the signs and symptoms of an abscess appear. Locally these can be classified into three groups:

I. Lesions developing on the posterior aspects of the vertebræ. Suppuration occurs along one or other of the spinal gutters on the posterior aspects of the neck or the torso. The symptoms are sharply demarcated and distinct and are those of a deep-seated abscess in the musculature of the back; the diagnosis is not made difficult by extraneous and associated factors. The swelling, at first purely œdematous, becomes indurated centrifugally, and softens in its centre where it overlies the affected bone. This stage may not be reached until the tenth day, and in many of the recorded cases the abscess was not observed until a much later date. When the abscess is opened denuded bone is generally detected at the bottom.

II. Lesions developing on the anterior aspects of the vertebræ—bodies, pedicles or transverse processes. The local symptomatology is much less clear. When the body of the vertebræ is affected the difficulties of diagnosis may

be immensely increased, because the abscess is situated so much more deeply. In the early stages, therefore, the tendency to maintain the supine posture, rigidity of the spine, and pain on movement, taken together with the general condition of the patient, in the absence of any indication of visceral disease or nerve complications, may be the only signs to depend upon. The various localizations of the accumulations of pus and the various paths along which these develop extend or migrate have been indicated previously (*vide supra et infra*). Because of these circumstances factors become introduced which are competent to hide the nature of the original disease and make difficult the essential diagnosis.
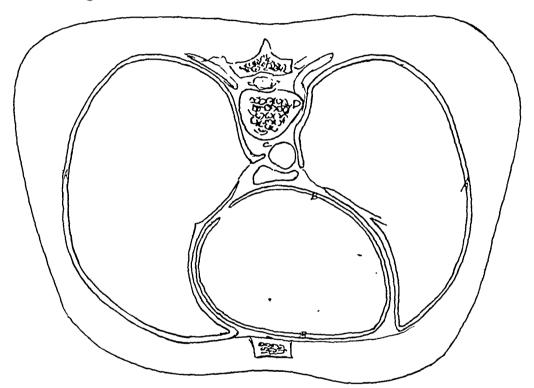


Fig. 4.—Transverse section of the thorax taken from the *Army and Navy Manual of Surgery*. To show the anatomical relationships of the plueræ A, the pericardium B, the mediastinum C, and the anterior aspects of the bodies of the vertebræ D, and their pedicles and laminæ; and the ease with which suppuration developing in front of the vertebræ can extend or break into any of these spaces.

III. Lesions develop in the depths of the vertebral arches and point into the spinal canal. Secondary effects upon the contents of the spinal canal—spinal cord and coverings—appear early. The local symptomatology also appears early and is sharply demarcated. It assumes the characteristics of inflammatory, or neoplastic disease of the cord and its meninges, or of myelitic changes in the cord substance produced by extraneous compression or by intrinsic degeneration of nerve cells and fibres. The phenomena of the bone inflammation are lost in the maze of neurological evidence.

COMPLICATIONS.—The factors summarized in groups II and III (immediately preceding) give rise to (1) a whole group of complications of osteomyelitis of the spinal vertebræ which are formed by the local extension of the

original vertebral lesion, as opposed to (2) another group of complications which result from the metastatic distribution of viable bacteria during the course of the primary general infection (bacteriæmia, general sepsis, pyæmia, etc.), to which the vertebral osteomyelitis was secondary. More in detail these complications are as follows:

1. Complications due to the local extension of the disease.

a. *Abscess of the Neck.*—These abscesses point in the posterior triangles of the neck. The one important symptom which calls attention to the bone origin of the abscess is rigidity of the neck and pain on the slightest movement or jarring of the head; this symptom should lead to the correct diagnosis even in the early stages in which röntgenographic evidence is not available. An illustrative case is the following:

CASE I.—A young boy of fourteen years complained of fever and malaise and at the end of the first week developed an abscess which pointed and was opened and drained behind the sterno-mastoid muscle. Several days later it was noted that a great deal of pain was associated with the dressings of the wound and that it was due to the movements and jarring of the head unavoidable during the manipulations attending the dressing. The diagnosis of osteomyelitis of the cervical vertebræ was made and confirmed by röntgenographic and other evidence. The boy did not do well; he later developed high fever and chills and eventually died from the effects of the suppuration.

b. *Retropharyngeal Abscesses.*—These nearly always occur in children and the diagnosis of the original bone disease can only be made by the X-ray or because of the ability to feel diseased bone in the depths of the abscess. The etiology of many of these retropharyngeal abscesses is undoubtedly lost in the further development of the lesion. An illustrative case is reported by Makins and Abbott:

CASE II.—The patient was sixteen years old. There was stiffness of the neck with pains between the shoulders and in the temporal regions. There was swelling of the neck after two or three days. On the ninth day the patient had fever and the neck became rigid. There was no fluctuation but there was marked tenderness at the level of the axis. An incision was made on the tenth day in the median line of the neck but no pus was found. On the twelfth day the tenderness extended to the middle part of the dorsal spine. On the thirteenth day there were pains in the ankles, elbows and shoulders. The patient had delirium and generalized hyperæsthesia and died the next morning. An examination post-mortem showed that the axis was denuded and rough; the periosteum of the atlas was softened. There was a retropharyngeal abscess at the level of the four first cervical vertebræ.

c. *Extrapleural (Retropleural) Abscess. d. Mediastinal Abscesses.*— These occur most commonly in association with osteomyelitis of the bodies of the dorsal vertebræ. A correct diagnosis is made with difficulty. Dysphagia from pressure upon the œsophagus, the appearances of pleural or pulmonary symptoms from direct extension of the inflammation and possible signs of pressure upon other structures such as the large intra-thoracic veins or important nerves, are the main elements that cause one to suspect such cases. Makins and Abbott report two cases. E. Schwartz and L. C. Wagner each report a case in which the diagnosis was made by X-ray evidence. An illustrative case is the following:

CASE III.—The patient was fourteen years old. There were pains in the back and left leg and the latter became red and œdematous. The general condition was very bad on the ninth day and abscesses were found on the anterior part of the left tibia and at the distal articulation of the great toe. These abscesses were incised. An abscess at the back of the foot was opened on the eleventh day. There were pains in the back on the fifteenth day and the patient died on the morning of the twentieth day.

The post-mortem examination showed that the left sides of the bodies of the second, third, fourth, fifth, and sixth dorsal vertebræ were bare and eroded, and in connection with them was an abscess containing about one ounce of pus situated behind the left
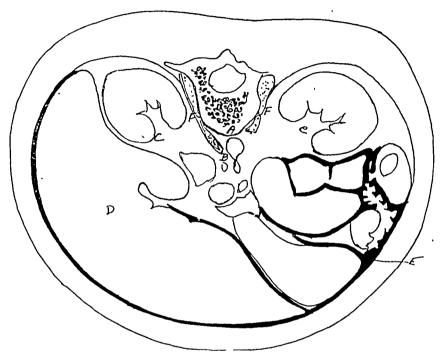


FIG. 5.—Transverse section of the abdomen through the liver and kidneys. Taken from the *Army and Navy Manual of Surgery*. Showing the relationships of the vertebræ on their anterior aspects A, the retroperitoneal space B, the kidney pouches C, the various aspects of the liver D, the peritoneal space E, and the underside of the diaphragm F, and the ease with which suppuration spreads into any of these directions.

pleura. There was great distention of the œsophagus and stomach, and the latter contained nearly three pints of foul-smelling fluid. The condition of the legs was as described above, and no secondary deposits were found in the viscera. The brain and cord were not examined.

*e. Pleurisy With and Without Effusion. f. Empyema Thoracis.*—These complications are usually associated with neighboring accumulations of pus resulting from disease of the dorsal segments. Mediastinal and retropleural forms of abscess most commonly antedate these pleural complications, and the mechanism is most commonly that of a free perforation. Clear effusions do not always antedate the empyema. The diagnosis of the pleural complication is always easily made. The diagnosis of the vertebral osteomyelitis has been made frequently but in some of the cases it escaped notice until the post-mortem examination. The cases terminate fatally very commonly owing to the general infection (bacteriæmia) or to other general or local causes, especially extensions of the suppuration into other important cavities or

viscera. Almost all of the men who have made contributions to the subject of osteomyelitis of the spine have seen or reported cases. Illustrative cases are the following:

Case IV.—A forty-six-year-old man developed malaise, high fever and sharp pain along the dorso-lumbar spine and over the left chest posteriorly. The pain was aggravated on deep breathing. Five days after the onset he was admitted to the hospital with a temperature of 104.6° F.

The physical examination showed rigidity of the neck, voluntary restriction of motion in the spine, definite lung signs in the left axilla, with signs of fluid, a negative Widal, a negative blood culture and meningeal signs. Aspiration of the left chest gave 15 c.c. of clear yellow fluid which contained 95 per cent. of polynuclear cells and staphylococcus aureus. The meningeal signs continued and the patient finally ceased about ten days after admission to the hospital.

*Post-mortem Examination.*—The left pleural cavity contained about 800 c.c. of a turbid reddish-yellow fluid, apparently purulent. This had displaced the heart to the right and had compressed the lung to about one-fourth of its original volume. The visceral layer of the pleura was covered with a shaggy fibrinopurulent material. In the left costovertebral angle was a large abscess cavity, larger than a fist, which was situated between the parietal pleura and the thoracic wall, and occupied the area reaching from the level of the eighth to the level of the twelfth dorsal vertebra. This communicated by a pin-point perforation with the left pleural cavity. The contents of the abscess cavity consisted of a very thick mucoid yellowish pus. The periosteum seemed to be lifted off from the left side of the body of the ninth dorsal vertebra, from its transverse process, and from the adjacent portion of the ninth rib. These areas felt roughened.

The spinal canal contained a large collection of stringy yellowish pus infiltrating between the dura and vertebral column from the level of the eighth dorsal vertebra down to the level of the first lumbar. The purulent process communicated through the eighth left vertebral foramen with the abscess cavity previously described in the left costovertebral angle. The left half of the spinal surface of the ninth dorsal vertebra is denuded of periosteum and markedly eroded. The purulent process had apparently started within it. Upon opening the dura there was found to be no increase in the cerebrospinal fluid and no visible pathological lesion upon the pia or within the cord.

Case V.—Morian reported the following case: The patient was seventeen years old. He had pains in the various joints, the head and back on January 6 and was obliged to go to bed. It was believed that he had pneumonia. He had high fever and stiffness of the neck and shoulders with tenderness of the spinal processes of the last dorsal vertebræ on January 11. During the following days fluctuation appeared at the level of the eleventh and twelfth dorsal vertebræ on each side of the median line. An incision was made on the twenty-third on the left side, and after it was found that there was denudation of the arch of the twelfth vertebra a grooved director was inserted into the abscess on the right side and a counter opening was made at that point. An iodoform dressing was applied. The patient improved for a short time but died on the twenty-eighth of cardio-pulmonary complications.

The autopsy showed that the bone was filled with pus. There was fluid in both pleural cavities and the lungs were very congested. Both pleuræ communicated with the vertebral abscess. The arch of the twelfth dorsal, its spinous process and the left lateral part of the vertebræ were denuded. There were several small suppurating foci in the bone. The spinal meninges were suppurating and there was injection and œdema of the pia mater. There were infarcts in the liver and the spleen.

*g. Pericarditis; Various Forms Including Suppurative Types.*—These lesions are found most commonly in association with pleural involvement.

Occurring by direct extension of the original focus of infection in the verte-bræ these pericardial complications are extremely rare, but when they occur as metastatic foci resulting directly from the original general infection (bacteriæmia) to which the spinal lesion is also metastatic, they are quite commonly found at post-mortem examination. Makins and Abbott and Ash-hurst and Wadsworth each report a case.

*h. Iliopsoas Abscess. i. Intra-abdominal Abscesses.*—These result from lesions in the anterior aspects of the lumbar vertebræ. The abscess forms rapidly and gives rise to the ordinary signs of local pain, tenderness, flex-ion of the thighs and pain on movement of the hip-joints. Owing to the acuteness of onset, a group of symptoms, namely, disten-tion of the abdomen accompanied by pain and tenderness, assume a dominating promi-nence and commonly throw the others in the background. The diagnosis is difficult and the essential nature of the disease has been mistaken for typhoid fever, appendicitis, per-itonitis, etc. The differentiation should, how-ever, be easily made from the local signs and symptoms re f e r a b l e to the spine, namely, rigidity, tendency to maintain the supine posi-tion, and the signs of a local inflammatory focus in the back overlying the spine. In d i f f e r e n t i a t i n g between enteric fever and osteomyelitis, it should be remembered that an enlarged spleen also occurs with ordinary general infections (bacteriæmia, pyæmia, etc.)



FIG. 6.—To show the iliopsoas mus-cle A. To show the path in the develop-ment of a psoas abscess from suppura-tion derived from any of the appropriate vertebræ.

Illustrative cases are the following:

CASE VI.—Three weeks before admission the patient developed a furuncle of the left buttock. The resulting abscess was incised. A few hours later she began to have pain in the left side and in the back so that she could barely move. Then she developed fever. The physical examination showed that the wound in the buttock was healed. There was no tenderness over the spine. In the lungs there was dulness and diminished breathing at both bases. The blood contained 160 colonies of staphylococcus aureus cubic centimeter.

About one week later a mass was felt in the left lower quadrant of the abdomen, extending from Poupart's ligament to about the level of the umbilicus; the mass was very tender. The mass grew larger and more tender. At operation the peritoneum over-lying the lumbar vertebræ was found to be thickened and œdematous. A large abscess was present in the depths of the psoas muscle. Later definite röntgenographic evidence of bone destruction was found. The patient was discharged from the hospital with an open sinus.

CASE VII.—The patient was in perfect health until three months ago when she suddenly noticed pain on the inner aspect of the right knee, radiating up into the right groin, which persisted. The pain was aggravated by motion or in damp weather. At the same time that the pains began she noticed large lymph nodes in her right groin which

were tender and increased in size. A mass the size of an orange could be felt in the right lower quadrant of the abdomen. Extension of right knee caused pain referred to upward to the groin with spasm. A kyphoscoliosis of the spine with sharp angulation laterally was present. Tender inguinal nodes were palpable. An adenoma of thyroid was present. The patient was in the hospital for eight days. For five days prior to death she ran temperatures between 100° and 104°. An X-ray study of the lower dorsal and upper lumbar spine showed a marked degree of spondylitis with bridging between the transverse processes of the second, third, and fourth lumbar vertebræ on the left side.

The post-mortem examination showed a large retroperitoneal abscess along the course of the psoas muscle. More than a litre of greenish pus was present and the psoas muscle was completely destroyed. The posterior wall of the abscess was formed by dense scar tissue which extended upward to the eleventh rib. After removal of this tissue which firmly adhered to the spine, the bodies of the third and fourth lumbar vertebræ were found to be eroded. The third vertebra contained a rather old abscess lined by a membrane of granulation tissue near the posterior surface. There were several smaller abscesses within the spongy bone of the fourth vertebra from which pus could easily be expressed.

CASE VIII. (Makins and Abbott.) A man of forty-six years developed pains in the back which gradually increased in severity. A large superficial abscess appeared in the right buttock on the twenty-first day. This abscess was opened on the twenty-sixth day. He had profuse diarrhœa. He died suddenly on the twenty-seventh day. The post-mortem examination showed that the superficial abscess which was opened communicated with a large abscess of the iliac fossa. The transverse process of the fourth lumbar vertebra was denuded and necrotic. The appendix was adherent to the anterior wall of the abscess. The bone marrow and the rest of the spine were normal.
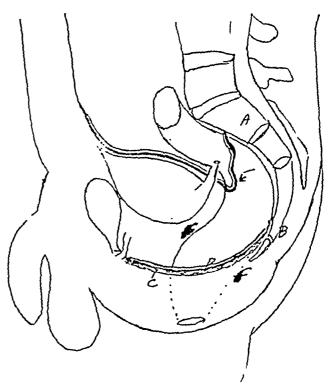


FIG. 7.—Antero-posterior vertical section of the pelvis taken from the *Army and Navy Manual of Surgery*. To show the relationships of the sacrum A and coccyx B, and the levator and muscle C, and anal fascia D, the reflection of the peritoneum E, and the perirectal and peri-anal F. Compare with the text for the various forms of the localization of any suppurating focus derived from the coccyx or sacrum.

*j. Various Forms of Pelvic Abscess, Ischiorectal, Para-anal, and Gluteal Abscesses.*—Many of the obscure and undiagnosed cases belong in this group. The diagnosis has often been made only at the post-mortem examination. However, in many cases the diagnosis of pelvic abscess was easily made but the essential pathology was not recognized or was only recognized accidentally. Makins and Abbott have seen extension of the suppuration to the sacroiliac-joints; and in one case a lumbo-sacral abscess formed concurrently with one in the pelvis. Makins reports the following very unusual case:

CASE IX.—The present illness commenced fifteen months before admission with the development of two small hemorrhoids. Later a discharge of pus and blood appeared

and continued from the rectum. Antiluetic treatment was of no avail. Then a peri-anal ulcer formed. A palliative colostomy was later done which terminated fatally eight days later. The post-mortem examination showed osteomyelitis of the fifth lumbar and first sacral vertebræ, bilateral pelvic abscess, perforation into the rectum, ulcerative proctitis, peri-anal ulcer, thrombo-phlebitis of the left common iliac vein. The entire process had evidently begun in the vertebra.

CASE X.—A peri-anal abscess recurred eight months after the original abscess had healed. Multiple fistulæ were present. During the revision necrotic bone was demonstrated in the sacrum and coccyx and a large abscess was present in the pelvic retroperitoneal space. The patient ceased. Permission for an autopsy was not obtained.

Daverne reports the following rather typical case:

CASE XI.—The patient was a child six years old who was admitted to the hospital for severe general symptoms characterized by a rapid pulse, high fever and the local signs of an endocarditis. There was nothing to indicate the existence of a purulent focus until a swelling appeared in the buttocks. On incision two abscesses were opened, one superficial and the other deep. There was denudation of the anterior surface of the sacrum and also of the bodies of the lumbar vertebræ, especially on the right side. The pus gave pure cultures of a staphylococcus. Improvement was extremely rapid. The child was able to leave the hospital two months after the operation completely cured.

*k. Various Forms of Disease of the Contents of the Spinal Canal.*—Complications due to involvement of the cord and its coverings either by pressure, by actual extension of the inflammatory focus or by both are frequently the cause of the symptoms which attract notice. The usual premonitory symptoms of interference with nerve function may pass unnoticed in consequence of the serious condition of the patient; or may possibly be ascribed to toxæmia. Later both sensory and motor disturbances occur. These include shooting pains in the limbs; hyperæsthesias of various kinds and extents, anæsthesias over definite areas corresponding to definite nerve centre or nerve trunk distributions, twitchings, tremors, convulsions, and paralyses of various kinds involving one or more muscle groups, limbs, the trunk, the rectum or the bladder. When the primary disease is in the neighborhood of the cervico-dorsal junction, pupillary disturbances may be elicited. Distention of the abdomen is another symptom which may point to secondary involvement of the intra-abdominal ganglia. The pathological forms under which the clinical symptom complexes appear include: (1) pachymeningitis externa; (2) intraspinal extradural abscess; (3) arachnoiditis and forms of serious effusion in the cord membranes; (4) spinal and cerebrospinal forms of purulent meningitis; (5) myelitis; (6) individual or muscle group paralyses including paraplegia. The following are illustrative cases:

CASE XII.—(Daverne.) The patient was a boy sixteen years old who had fallen on his back. He had rather sharp pains but was able to continue walking and working for four days. Then he developed chills and fever. The severe pains in his back continued. At the hospital a diagnosis of typhoid fever was made because of the signs of general infection and prostration. However, considerable œdema of the lumbar region with marked pain on pressure was noted. There were no signs of spinal meningitis. On incision, a rather large abscess was found within the sheaths of the deep muscles. The laminæ and the spinous process of the third lumbar vertebra were denuded. The wound

was drained. The patient died during the night. The pus contained a large number of staphylococci.

The autopsy showed: a beginning bronchopneumonia; an osteomyelitis confined to the laminæ and the spinal process of the third lumbar vertebra; and an *extradural abscess*. The cerebral spinal fluid was normal.

CASE XIII.—(Daverne.) A boy six years old who had always been in good health suddenly had high fever and severe thoracic pains. Three days later he had a paralysis of all the territory below the third thoracic vertebra. A diagnosis was made of *compression of the cord* by pus or blood. A long incision was made and the spine was trephined. Much pus escaped from the spinal canal but the dura mater was intact. The child died. No autopsy was made.

CASE XIV.—(Daverne.) The patient was a man thirty-four years old. Within a week's time he developed high fever, a very bad general condition, pains in his knees, delirium and slight deafness, difficult respiration, unconsciousness, convulsions, and coma. There was no paralysis. The patient died.

The autopsy showed a *serous effusion of the arachnoid*. There was a double psoas abscess, more extensive on the left side. There was an osteomyelitis of the body of the first lumbar vertebra. The inter-vertebral disc between the first and second lumbar vertebræ was completely destroyed and the abscess communicated with the peridural space.

CASE XV.—(Lucas.) The patient was a man twenty-one years old who complained of pains in the back, loss of appetite and constipation. He became progressively worse, became delirious, and finally completely unconscious. There was stiffness of the neck and rigidity of the spinal column. The diagnosis made during life was typhoid fever.

The autopsy showed *peri-meningitis and suppurative meningitis* at the base of the cranium, sero-purulent pleurisy, infarcts of the lung, kidneys, prostate and liver, severe pulmonary emphysema and œdema, and large psoas abscesses due to lesions of the third, fourth and fifth lumbar vertebræ.

CASE XVI.—(Lucas.) The patient was a child nine years old who had headache and stiffness of the neck. The general condition became very bad on the fourteenth day and there was a high remittent fever. An abscess of the neck was opened on the twenty-first day. There was a swelling over the right great trochanter on the twenty-fourth day. He became delirious on the twenty-eighth day and died that evening.

The autopsy showed that the posterior arch of the atlas was necrotic and was separated into two fragments. There was a perforation of the dura mater and the intradural space contained a large amount of cloudy fluid. There was *basal meningitis* and *pus in the anterior horn of the lateral ventricles*. There were secondary abscesses in the lungs.

CASE XVII.—(Makins and Abbott.) The patient was a child ten years old who had pains and then swelling of the back. On the tenth day there was a large abscess at the level of the lumbar vertebræ which had retained their normal mobility. The abscess was incised and it was found that the third lumbar spinal process was denuded. His pulse became very weak on the eleventh day and respiration was rapid and superficial. There was œdema over the left great trochanter. He lost consciousness on the thirteenth day. Both sides of the body then became rigid. He died on this day.

At the post-mortem examination the laminæ of the third lumbar vertebra were found to be necrotic and there was separation of the spinous process. All the regional muscles were infiltrated with pus and the pus extended also into the spinal canal. The spinal arachnoid was congested. The parieto-occipital part of the left lobe of the brain was softened. There were infarcts and abscesses of the viscera.

CASE XVIII.—An infant developed fever and the mother noticed that the child did not move the left arm. There was an area of induration in the posterior part of the neck. Later the paralysis involved the other arm. The paralysis was of the flaccid type and the reflexes were lost. The lower extremities were somewhat spastic. Anæsthesia of the upper

extremities was defined. An incision was made in the neck and an abscess was drained; denuded bone was palpated in the spinal vertebræ. There was a complete recovery.

CASE XIX.—The patient was a girl twelve years old. She received an injury to her back. Six months later she complained of chills and pains in the legs and back. She had paraplegia on the fourteenth day of the illness. The paralysis was more severe on the left side at first and then complete as far as the thorax. There was a little œdema at the level of the cervico-dorsal region of the spine. The spinous processes of many vertebræ were tender on pressure. She had retention of urine. A diagnosis was made of an ascending myelitis.

The paralysis remained stationary for about one month, the retention changed to incontinence and the temperature decreased. Then it rose again about one month later, and a large abscess was found to the left of the first three dorsal spines. This was incised and it was found that the left lamina of the second dorsal vertebra was completely necrotic as well as the greater part of the spinous process. The right lamina was deprived of its periosteum but was not necrotic. This was also removed, as well as the left transverse process which was infiltrated with pus. A large amount of pus had extended into the spinal canal and the dura mater was covered with a membranous exudate. The wound was drained. No signs of tuberculosis were found.

After a period of improvement during which the anæsthesia descended about three inches, symptoms of cystitis appeared. The patient died three weeks after the operation. No autopsy was performed.

2. Complications resulting from the general infection.—The complications resulting from the general infection form a very important group and consist of metastatic foci of infection resulting from the general distribution of bacteria within and throughout the body via the vascular circulation during the course of the bacteriæmia (sepsis, general infection, etc.) from which the vertebral lesion itself resulted. In those cases in which the vertebral focus of infection itself becomes a secondary point of distribution similar lesions result in an exactly like manner during the period in which the secondary bacteriæmia is present. These metastatic foci can be arranged in the following general groups:

a. General toxæmia. b. Osteomyelitis in other bones. c. Suppurative and non-suppurative forms of infection in the various joints. d. Infection of the hollow spaces: (A) empyema; (B) pericarditis; (C) peritonitis; (D) cerebrospinal meningitis; etc. e. Endocarditis. f. Minor abscesses in the fascial planes, etc. g. Lung abscesses. h. Renal infarcts.

Discussion of these groups will be omitted from this communication as beyond the scope of this paper.

Mortality.—The mortality of vertebral osteomyelitis is very large. The general mortality according to Donati is 53 per cent. If the infection extends to the meninges, the mortality rises to 64 per cent. according to Schwartz; and to 71 per cent. according to Makins and Abbott. The mortality for lesions in the arch is 33 per cent. as opposed to a mortality of 78 per cent. for lesions in the body (Donati). Lumbar involvement carries a mortality of 65 per cent., dorsal involvement of 27 per cent., and cervical involvement of 44 per cent. (Donati). Before 1890 the published general mortality reached 81 per cent.; between 1890 and 1900 the mortality was 48 per cent.; and between 1900 and 1905 Donati estimated the mortality to be 22 per cent. This, of course, showed

a continued improvement. Since 1905 the mortality can be estimated to range in the neighborhood of 35 to 45 per cent., depending on the kind and character of the complicating factors. In the nine cases reported in this communication the mortality was 44 per cent.

*Prognosis.*—As far as the material to hand goes, it seems that on the whole affection of the posterior neural arch is a more favorable condition than that of the body, although nerve complications are more frequent. This seems to be so because in this situation the disease is more likely to be recognized at an early stage. Then operative intervention will be most effective, as sufficiently early incision may arrest further mischief. With regard to disease of the bodies, only increased experience can show whether a more exact knowledge of the affection will allow the complicated abscesses to be earlier detected and treated; local disease is within the bounds of surgical therapy. Cases of posterior mediastinal abscess from the difficulty of localization are naturally less hopeful. In any case in which mediastinal abscess is suspected, and this naturally applies especially in cases of involvement of the thoracic spine, repeated X-ray examination should be practiced as early as possible in order to detect these localizations as speedily as possible.

*Treatment.*—The general principles governing the treatment of acute osteomyelitis in general have been described on several previous occasions and they will not be repeated here except in summary: Suffice to say that the cases group themselves into (*a*) the highly fulminant cases in which the general infection is of such a virulent nature as to make futile any attempt on our part to control the disease; (*b*) less fulminant infections, but very sick patients with large numbers of viable organisms being discharged into and circulating in the blood stream in whom a radical attack on the local bone lesion is made for purposes of controlling the bacteriæmia; (*c*) the ordinary cases with bacteriæmias of small or moderate extent, or with sterile cultures in which treatment resolves itself down to the ways and means which will lead to the greatest conservation of form and function and to the best general advantage of the individual patient.

These groupings seem almost best exemplified in the cases of acute osteomyelitis of the spine. The literature leads one to believe that in previous times the principles of treatment previously described by me have hitherto been employed by surgeons on empiric grounds in the absence of any of the newer knowledge. This state of affairs continues to exist to-day even though knowledge of bacterial infection in all of its manifestations—thrombophlebitic lesions, bacteriæmia, etc.—has been increased to a very large extent and the importance of this factor is especially understood in acute osteomyelitis in general. In osteomyelitis of the vertebræ the general use of conservative measures is forced upon the surgeon; radical measures of any kind are not possible because of anatomical and mechanical reasons; and the available therapeusis resolves itself down to (*a*) the treatment of the local lesion in the bone; and (*b*) to the relief of the neurological complications of the local lesion. Measures directed to the relief of the general infections are of little

practical importance in cases of sepsis associated with osteomyelitis of the spine and play little, if any, rôle in the progression or subsidence of the associated general infection.

The treatment of the bone lesion itself is necessarily confined to the treatment (proper incision and adequate drainage) of those accumulations of pus previously described in this communication whenever these can be located and reached surgically. These are of three kinds (*a*) abscesses on the posterior aspect of the spine; (*b*) abscesses on the anterior aspect of the spine; and (*c*) accumulations of inflammatory tissue or of pus within the spinal canal.

*A.* Abscesses on the posterior aspect of the spine are usually rather simple affairs and their proper incision and drainage require nothing more than the simplest of procedures. Subsidence of the tremendous reaction which is frequently present follows quickly after which, when no untoward complications arise or when no sequestration has occurred to delay the healing of the wound, cicatrization proceeds in the normal way. The pus accumulations are commonly at a considerable distance from the skin surface.

*B.* Abscesses on the anterior aspect of the spine are much more difficult to handle. In those complications in which the abscesses accumulate in the hollow cavities or in obscure and difficult positions, the necessary drainage can be a procedure of much difficulty and of considerable magnitude. Such for instance are the mediastinal and high pelvic abscesses, or the deep-seated subdiaphragmatic abscesses. In a general way the abscesses can be grouped for operative purposes and for securing adequate drainage as follows:

1. Abscesses of the neck. These are of two kinds: (*a*) Retropharyngeal abscesses can be reached in the usual way through the mouth. If the abscesses show any tendency to fill up again, it is much more advisable to abandon the oral route and to drain the abscess frankly from the outside of the neck. Usually this is much more safely accomplished by making the incision posteriorly to the sternocleidomastoid muscle; the latter, when retracted forwards, carries with it the vessels and other important structures and brings one down directly onto the para—and posterior pharyngeal space; this gives a safe channel through which the abscess can be reached and drained. Frequently one or several glands which are enlarged and lie in the drainage path must be removed before the abscess is actually opened.

(*b*) Ordinary forms of abscesses of the neck. Owing to the anatomical arrangements, these either lie in the anterior triangle of the neck or, more commonly, in the posterior triangle. In either case it is the better part of wisdom to allow the abscess to come to the surface (poulticing); incision and drainage of the abscess is then a simple matter.

2. Intrathoracic accumulations. Localized mediastinal, retropleural and all varieties of intrapleural abscesses (empyema) have a much better prognosis than the diffuse form of mediastinitis. Favorably placed mediastinal and retropleural abscesses can be classed with localized empyemas and should be incised and drained according to the best principles in use for drainage of empyemas in general. Unfavorably placed mediastinal abscesses or the

diffuse forms of mediastinitis are not so simple and procedures of greater magnitude are necessary for their proper drainage. The best approach is by posterior mediastinotomy with the resection of adequate lengths of a sufficient number of ribs at their angles and posterior extremities to furnish a wide approach to the mediastinum. The procedure is relatively difficult and suffers from the danger which all operations of this kind entail—namely, that the suppurative process is caused to spread rapidly in the loose cellular tissues of the mediastinum, where it rapidly escapes beyond surgical control and usually terminates fatally.

Suppurative forms of pericarditis are usually extensions of previously existing accumulations of pus or they are metastatic lesions. In either case they must needs be drained in the usual way by pericardiotomy.

3. Intra-abdominal abscesses. General surgical principles are employed in the incision and drainage of these abscesses. A few of these can be reached by the extraperitoneal route; others must be reached trans- and intraperitoneally. Some, which are operated upon late, point in the usual position of a psoas abscess; these are easily drained extraperitoneally. Others are deep in the abdomen and close to the spine and sometimes high up in the abdominal cavity; these are reached with greater difficulty.

4. Pelvic abscesses. These can be grouped as (*a*) high pelvic; (*b*) ischio-rectal; and (*c*) para-anal abscesses. The latter are the simplest. Ischio-rectal abscesses should be allowed to come down as far as possible when their proper incision is much simplified. High pelvic abscesses are most difficult. In a certain number resection of the coccyx and possibly of the lowermost part of the sacrum is necessary in order to secure adequate drainage. The difficult ones are those which pass out of the pelvic cavity and point in a superficial location as, for instance, some of the gluteal abscesses. The rule is to suspect an intrapelvic origin for any gluteal abscess in which there is marked retention of pus and which shows any tendency to have a much protracted healing stage.

As a general rule no attempt to remove bone tissue should be made in any of these groups of cases when opening and draining any of these abscesses. This rule should not be broken because of the following reasons:

1. Sequestration frequently does not occur and the abscesses are to all intents and purposes subperiosteal abscesses which will heal promptly when drainage is thoroughly established.

2. It is absolutely impossible to demarcate the healthy from the diseased bone and the mechanical principles upon which the spine is built are so important that it is inadvisable to remove unnecessarily any important part of the structure which the operator might be tempted to do unwittingly in any radical bone removal.

3. When necrosis of bone does occur this will be of minimum size, commensurate with the size and position of the thrombophlebitic lesion, when the natural process of sequestration is allowed to go on undisturbed. The necrotic

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portion should be removed from the wound only when it is thoroughly separated, or it can be allowed to discharge itself spontaneously from the sinus at a subsequent period.

Healing is as a rule a protracted affair. Revisions are often necessary and must be repeated sometimes. The usual findings at these revisions are devious and sometimes complicated sinus tracts with or without the presence of sequestra. Some of these tracts wind in and out and around the foramina and various processes of the individual vertebræ. In some of the cases insufficiently drained deep seated pockets are found.

Orthopedic appliances are generally not called for except in cases of osteomyelitis involving the cervical spine.

*C*. Suppuration or inflammatory exudate within the interior of the spinal canal. This group includes the neurological complications of osteomyelitis of the vertebra and as such forms a distinct therapeutic group inasmuch as the principles of treatment are not determined by the local lesion so much as by the character and extent of the neurological symptoms. The group includes the following:

1. Cases of frank meningitis. At the present stage of knowledge meningitis is for practical purposes a fatal complication. Medical or surgical measures seem of no avail. Recovery is a rare exception.

2. Cases in which the neurological complication consists of a compression of the spinal cord. The indication is to do a spinal decompression (*i.e.*, the removal of the spinous processes and the laminæ up to the junction with the pedicles) and to deal with the pathological condition which presents itself. In those with extradural exudate simple decompression is sufficient. In those with extradural abscesses drainage of the latter is necessary in addition. There are numerous instances in which either one of these two conditions, or possibly both, is combined with other pus accumulations outside of the spinal canal and in these the decomposition forms part of the procedure which must be done. The promptness and rapidity with which relief of symptoms follows the decompression indicate in most of the cases of pure compression the promptness with which the complication has been recognized and relieved. Usually the symptoms appear rapidly and with sufficient dominance to make recognition of the complication and its immediate relief a rather simple matter.

A curious condition was found in one personal case. A young child was admitted to the hospital with an abscess of the back close to the median line, the origin of which in the spinal vertebræ was not at first recognized. The abscess was incised and drained and for several days thereafter the convalescence proceeded as it should. Then a clear watery fluid, evidently cerebrospinal fluid, began to escape from the wound. Examination of the wound showed that the fluid came from a narrow sinus which passed inward in the general direction of the spinal canal between two of the laminæ. In spite of the fact that there was no possibility of preventing contamination and infection, the escape of cerebrospinal fluid was accompanied by no untoward manifestation and cicatrization of the wound and closure of the fistula proceeded uneventfully until complete healing of the wound.

3. Cases in which the neurological complication is a myelitis. These are sometimes difficult to distinguish from the cases of pure compression. In any case it seems justifiable to decompress the spinal canal and its contents in the hope that relief will follow.

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# CARPAL OSTEITIS

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FROM THE PORTLAND CLINIC

HEREWITH are presented eight cases of osteitis of the carpal bones. Three are definitely traumatic in etiology; three are apparently occupational; in one the cause is unknown, and one, occurring in a child of twelve years, seems to be comparable to Köhler's tarsal scaphoiditis. The clinical signs, symptoms, and course in all have been the same. All began with pain and swelling in the wrist, tenderness on pressure over the bone or bones involved. Stiffness was present in all: in some, slight, in others, marked. Dorsal extension was limited to a greater degree than palmar flexion and passive movement in these directions caused pain. There have been periods of complete and comparative freedom from clinical symptoms, followed by an aggravation of disability, usually without cause.

Of the bones involved the scaphoid and semilunar predominated, but in one here classified as occupational, both wrists were affected and all bones showed X-ray evidence of the destructive process.

The name Kienboch's disease has been applied to this condition when the semilunar alone is affected. Goldsmith has recently reported three cases, and noted one hundred more listed by Finsterer prior to 1909, and later Henderson described two cases and stated that the disability as a clinical entity is usually not recognized, and the objective symptoms may be so slight that a suspicion of malingering may well be entertained. He says: "The syndrome in typical cases is characterized by three stages: (1) the acute, lasting possibly only a few hours, coming on immediately after the injury, rarely lasting more than a few days, and generally not more than a few weeks; (2) the period of freedom from pain and disability, sometimes lasting as long as two months, and (3) the period of actual disease in which the osteitis definitely assumes form and persists with symptoms for years." The X-ray picture is quite typical, but varies as the condition progresses. If taken immediately after injury, or soon after symptoms are noted, no particular change is seen. Early, however, there is an increase of density in the bone. Later, when malacia begins, clear areas appear. The articular cartilage may retain its outline for years before complete crumbling takes place. Disease of the scaphoid has been known as Preiser's disease. Preiser described a post-traumatic osteitis which led to spontaneous fracture of the scaphoid. He concluded that rarefaction preceded the fracture.

It is well known that fracture of the scaphoid and semilunar are followed by osteitis, but in none of the following cases was the original injury severe enough to cause fracture. Two X-rays taken later showed definite fragmentation.

Buchman, in reporting seven cases, calls this disease osteoporosis of the carpal bones. He has found the scaphoid, semilunar, or magnum and unciform involved.

## CASE REPORTS

CASE I.—Miss V. W., twenty years of age. This patient stated that when she was eleven years old she fell on an outstretched hand, injuring her wrist. The only disability she remembers was the inability to play the piano for six months. For seven years the wrist caused no trouble. Then, on account of pain and swelling, she consulted a physician, who diagnosed her condition as chronic sprained wrist. She wore splints for six weeks and has had recurring attacks since that time.

Examination revealed swelling in the dorsum of the wrist, pain on pressure over the semilunar and a marked degree of muscle spasm. The hand was fixed in slight palmar flexion. The X-ray revealed an ovoid rarefaction in the dorsal tip of the semilunar.



FIG. 1.—CASE III.—Showing cavity formation in all of the carpal bones and bilateral involvement.

There was no evidence of fracture. The bone about the punched out area was denser than normal bone.

CASE II.—Mr. J. K., fifty years of age. While scuffling six months previously patient fell on extended hand. The wrist swelled slightly and was painful, but this soon subsided, and he thought nothing more of it. Four months later he again noticed swelling and had an X-ray taken of the wrist. He was told that the X-ray was negative and that he had a chronic sprain of the wrist.

Examination revealed slight swelling of the affected wrist, pain on pressure over the scaphoid in the anatomical snuff-box, and limitation of movement in extreme limits. He brought his X-ray, taken two months before, and it showed two definite areas of rarefaction in the bone of the scaphoid. A year later definite fissure has taken place and the bone is now divided.

CASE III.—Mrs. J. A. C., a seamstress. This patient has had pain, swelling and stiffness in both wrists for one year. No other joints are or have been involved. The pain comes and goes. The attacks are accompanied by temperature, as high as 101.5°. There is no permanent stiffness. X-ray of both wrists (Fig. 1) showed punched out

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areas in all the carpal bones. This case is unusual in the number of bones involved, in the severity of the attacks which are accompanied by fever, and in the bilateral involvement.

CASE IV.—Mr. W. K., fifty-eight years of age. Automobile painter. This patient presented himself for treatment stating that he caught a steel jack as it was tipping over and sprained his wrist. He also said that the accident causing the injury was a very minor one and he could not account for the severe swelling and pain. Both wrists have been swollen at different times, but he does not recall laying off on account of this.

Examination revealed swelling and pain on pressure over the scaphoid of the right



FIG. 2.—CASE VI.—Showing two large cavities in the semilunar bone, with increased density of surrounding bone.

wrist. Both wrists were X-rayed and in both the scaphoid was found divided. The contiguous surfaces were irregular in outline, the bony structure was quite dense and several rarefied areas were seen. This is apparently an occupational condition; the patient uses both hands continuously in his work, using a cleaning brush with his left hand and painting with his right. The separation found in the X-ray is not congenital, because of the sharp outline of the fragments and the irregularity of their contour.

CASE V.—Mrs. F. B. S., fifty-six years of age. For years this woman had what was called arthritis of the wrist. There were periods of complete freedom from pain, followed by swelling, stiffness, and inability to use the right hand. Two weeks before examination she fell, injuring her wrist severely. The X-ray revealed a fracture of the styloid of the radius and a large cavity in the semilunar. This patient has apparently had an osteitis of the semilunar for a long time, which would no doubt have remained undiagnosed except for the X-ray examination incident to the severe injury.

CASE VI.—K. M., forty years of age. Typist. Pain in the wrist for years, diagnosed by a number of physicians as chronic sprain of the wrist.

Examination revealed slight limitation of motion, no apparent swelling. Pain on pressure over the semilunar. The X-ray (Fig. 2) revealed a large cavity, involving most of the bone. This patient found it necessary to change her occupation on account of her wrist disability. Later X-rays, after prolonged physiotherapy (diathermy), revealed a filling in of this very large cavity. Clinical symptoms have not recurred for a year.

CASE VII.—Dorothy S., twelve years of age. Swelling of the right wrist noticed by mother for six months. The X-ray revealed a flattened semilunar with increased density and cavity formation. This case has the appearance of Köhler's tarsal scaphoiditis. This may be the type of case that previous authors have compared to Osgood-Schlatter's disease, Legg-Perthe's disease, Köhler's disease, and the osteochondritides. Buchman does not agree with this classification, but this case occurred during active growth and may well be placed in this group. However, I have not been able to find in the literature any case previously reported occurring in the growth period.

CASE VIII.—Miss A. P., thirty-eight years of age. Typist. Injured by falling with outstretched hand against a seat in a railway train. Inability to work at her occupation for three months. Limitation of movement in dorsal flexion. Pain on pressure over the scaphoid. X-ray findings: "There is an irregular area in the scaphoid in which the normal striations are not seen; rarefaction is present. Bone absorption has taken place."

The problem of disability entered into this case. The X-ray findings, though positive, were not clear cut. However, pressure in the anatomical snuff-box caused severe pain, and the patient continued treatment at her own expense after a settlement had been made.

*Treatment.*—Treatment has consisted of the application of heat by means of diathermy and of immobilization. In some cases treated over an extended period of time we have seen filling in of the bone cavities and the disappearance of symptoms. We have not found it necessary to remove the bones in any case.

This disease is apparently a distinct clinical entity. It is comparatively common and is often overlooked. The X-ray findings of cavity formation are positive proof of its existence, the X-ray being quite distinctive.

Trauma is not the only etiologic factor. Two cases here reported, one with febrile reactions and the other in a child, do not come under this etiologic classification. The term carpal osteitis seems a fitting term to include both the traumatic and non-traumatic types.

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# FRACTURE OF THE CARPAL SCAPHOID*

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Although fracture of the carpal scaphoid had been clinically well described over a hundred years ago, it was not until the X-ray increased the accuracy and extent of our knowledge that its study was put on a more scientific basis. No less than thirty years ago Doctor Stimson, before this Society, made the statement that "fracture of the carpal scaphoid was usually attended by complete disability of the wrist." Since that time the serious disability consequent to this injury has led to numerous papers on the subject. The tendency in the past of some surgeons to look upon the result as being inevitably unfavorable is to be deplored. The appropriate method of treatment of this condition awaits more extensive data from the follow-up reports of patients suffering from this injury. For this reason the author wishes to make this report of a group of his own cases, seventeen in number, the follow-up results of which extend from one and a half to ten years.

*Occupation.*—Five of the cases were firemen, *i.e.*, men exposed to trauma. Otherwise irrelevant.

*Age and Sex.*—All of the patients were adult males between twenty and fifty years of age.

*Mechanism.*—The violence in most cases was indirect. The suddenness of the trauma and the attending pain made description of the accident too problematic to be of use. Two types of fracture were present, *i.e.*, (1) those of body; (2) those of tubercle.

At the time of injury it was thought that the usual position of the hand was that of radial or ulnar, as well as dorsal, flexion. This condition was obtained usually in falls on the outstretched hand, especially in backward falls when the hand was dorsally and radially flexed. It has been shown experimentally by Cousin and Gallois and by Hirsch that if the hand was not in extreme dorsal flexion then the relaxed ligaments allow full mobility to all the carpal bones, so that there cannot be a concentration of the force on any single bone. When, however, the hand was in dorsal and radial flexion the scaphoid was fixed in the articular cavity of the radius. The impact of the head of the os magnum into the concave side of this bone, fixed medially by the semilunar and laterally by the trapezoid and trapezium, usually caused it to fracture transversely in its relatively contracted middle diameter. For this reason others have called the scaphoid the buffer bone and its position between the under surface of the radius and the head of

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the os magnum as the position of contention. Fractures of the tubercle of the scaphoid are extra-articular and are probably accomplished in the position of extreme ulnar flexion by the dense lateral radial ligament.

*Pathology.*—Fifteen cases showed transverse fracture through the body of the bone, *i.e.*, all of these were intra-articular. Of the two others one showed a fracture through the tubercle and the other showed a chipped fracture of its outer surface. In none of the cases was there displacement of the bone fragments. One patient showed a large central area of destruction due to comminution. With the exception of two patients who showed three fragments each, all of the other scaphoids were fragmented into two pieces. One patient had had fracture of both scaphoids with about a year's interval.

*Symptoms and Signs.*—The cases were divided in this basis as *acute*, of which there were eight; and *chronic*, of which there were nine.

*History.*—*Acute Cases.*—The usual history of violence was similar to that of a Colles's fracture or a sprain of the wrist. Pain was the most constant symptom. It varied in intensity and while usually very severe it was occasionally so slight as to be misleading. With the pain there was disability especially in pushing from a cock-up position. There was swelling over the outer area of the wrist with obliteration of the snuff-box. Ecchymosis is generally lacking. Tenderness was present in all, being most marked in the snuff-box when the hand is in a position of ulnar flexion. The percussion sign obtained by percussing the head of the middle metacarpal with the hand in radial flexion was not of value to us. X-ray was the most important diagnostic method. As pointed out by Chase and Codman more than twenty years ago, the best results are obtained by X-raying both wrists. The palms are placed downward, in ulnar flexion, with the thumbs together. The tube is centred over the radial styloids. This rules out also the possibility of a bipartite scaphoid being mistaken for a fracture as well as tending to show more clearly the fracture line in doubtful cases.

*Chronic Cases.*—There were nine in number. Eight of these had been diagnosed as sprains of the wrist. The ninth was discovered in the course of an X-ray for another purpose about five years after the injury. The history, when it was remembered, was usually that of a so-called sprain of the wrist.

None of these cases had either the benefit of X-ray or immobilization, although all but one were treated by physicians. Varying degrees of persistent discomfort or pain in the affected wrist, stiffness and disability were present in all but two cases from a slight amount to almost complete loss of function. These latter two cases showed only slight pain, but no limitation of function. On examination there was tenderness, as a rule, present in the snuff-box. One patient showed marked bony crepitus. Limitation of function was present in seven out of the nine patients varying from a slight degree to almost complete stiffness at the joint. The X-ray of these chronic cases was characteristic. The line of fracture was distinctly seen in all as bony union had failed to take place. The pathological changes which have

been so often described were seen variously in these X-rays. Rarefaction of the fragments, loss of substance, cavity formation and adjacent osteo-arthritic changes were present in varying degrees. As Speed has pointed out, extreme pain and almost complete disability may follow fractures without any apparent osteo-arthritis. Conversely in two of these patients there were very marked pathological changes present with only slight degree of pain and lessened function resulting. (Fig. 1.)

*Treatment.—Acute Cases.*—Every case with the symptoms or signs suggesting this injury was immediately X-rayed. Of the eight cases all were seen from within a few hours to thirty-six hours after injury. On confirmation of the diagnosis they were immobilized in either bilateral moulded plaster splints or in a split roller case. The plaster was carried from the tips of the fingers to the elbow. The thumb was abducted and the wrist was put in the cock-up position. The period of immobilization varied



FIG. 1.—Watchman, aged sixty years. Untreated fracture five years after probable occurrence with failure of union in the three fragments. The patient had little discomfort and only moderate loss of function and power. The bony fragments, however, showed the most extensive degenerative changes. There were no changes noted in the adjacent carpal bones. The pathological picture was out of all proportion to the relatively slighter clinical findings.

from six to eight weeks. Most cases were treated for the latter period. This time was selected from the standpoint that active bone repair in the scaphoid, especially in intra-articular fracture, is much less active than in fractures of the long bones. Protection during this period of repair must be maintained until union has definitely progressed. The two fractures of the scaphoid tubercle since they were extra-articular and required less protection were immobilized for periods of three weeks respectively. Following the removal of the splint physiotherapy was used when possible as an adjunct in the stage of convalescence. The treatment of these cases by this method was too casual to draw any conclusions.

*Results.—Acute Cases.* -Both fractures of the scaphoid tubercle obtained the usual excellent re~ .. When examined one year after their injury there was no evidence of any pain or disability. X-rays were not taken at follow-up. The six remaining acute cases of fracture of the body were examined and X-rayed from one to eight years after injury. X-ray showed three cases to have bony union. These patients were symptomless and showed

excellent function. These surprising results were obtained in city firemen, all of whom were able to resume their full occupation within four months after their injury. The other three acute cases showed failure of bony union. There was only slight disability and no discomfort present in this latter group. One of them, a professional pugilist, was able to carry on within six months with about 10 to 15 per cent. diminution of function; another, a physician, at the end of eight years has only slight discomfort and no disability, although this last patient's X-ray shows distinct bony changes in both fragments of his scaphoid. (Fig. 2.)

The poorest result was that of a patient whose limitation of function was about 25 per cent., but in view of his moderate discomfort he was willing to tolerate this condition rather than be subjected to any operative procedure. The lack of symptoms and the good function obtained by the early treatment of these cases even when bony union is not obtained seems inconsistent with the X-ray picture. Possibly union may be present, although it may not be bony union.

*Treatment.—Chronic Cases.*—There were nine: five were non-operative; four were operative.

*Non - Operative*



Fig 2 —Eight year old fracture treated by immobilization in acute stage with failure of bony union and definite changes in both fragments and adjacent osteoarthritis. The patient has no pain and no loss of function or power. This illustrates difficulty of forecasting clinical findings by mere examination of the X ray.

*Group.*—One of these patients with non-union, following an untreated fracture of several years' standing, refused operation. Conservative immobilization did not diminish his symptoms of discomfort and mild disability. He is classified as a poor result. Another of these patients had been injured twenty years previously and had been treated only with a wrist band over a period of several weeks, having been told that he suffered from sprain of the wrist. Here there were only slight limitation of function and mild discomfort, although his X-rays showed extensive bony changes in both fragments with evident osteoarthritis. The pathological picture is out of all proportion to the functional and symptomatic result. He is content, in view of the fact that nothing could be gained by operation, to have no treatment. (Fig. 3.)

Three others examined from one to five years after their injury showed moderate pain and moderate loss of function. In view of the fact that they all had sedentary occupations, they were willing to tolerate their condition since only operative treatment could be advised.



FIG 3 —A twenty year old untreated fracture with failure of bony union There is extensive bony change in both fragments with osteoarthritic changes also evident In spite of this patho logical picture the patient has no pain and only slight loss of func tion in extension His wrist power is not impaired

*Operative Group.*—The four remaining chronic cases were treated by operative measures. The earliest one of this group was treated by excision of the small proximal fragment. The result three years later showed that although his pain had disappeared his function was unimproved. A following X-ray taken immediately post-operative showed a small bony shadow in the capsule at the site of the removed fragment. Three years later this area had grown distinctly and the presence of crepitus on active and passive motion indicates that this may be a remote cause of further disability. (Fig. 4.)

There is, however, no change in the X-ray appearance of the remaining

fragment or in that of any of the other carpal bones, although the prevailing opinion amongst writers on this subject is that all fragments of the injured scaphoid undergo progressive osseous degeneration. The three other chronic cases were treated by removal of all fragments. The most dominant symptom in these cases was pain and all of them received early and permanent relief from this symptom following the operation. The relief of chronic pain seems to me to be the real indication for operative removal of the bone fragments. Function, unfortunately, may not be similarly improved. (Fig. 5.)

One must be careful not to be too sanguine of improving the range of motion or the strength of wrist power in these chronic cases by excision of the fragments. In two of these complete excision cases small areas, evidently bony shadows, were noticed in the capsule post-operatively. They were thought to be the result of the removal of the adherent fragment which is often large and on·account of its dense attachment to the sur-



FIG. 4.—Chronic case of fracture with failure of union and severe resulting pain. The proximal fragment was removed easily. An X-ray taken post-operatively showed a small shadow, evidently a bony deposit at the site of removed fragment. This is shown by the arrow to have increased about two-fold in the past five years. The pain for which removal was performed was relieved and has not recurred, although this bony deposit is much larger.

rounding ligaments involves the risk of leaving small collections of bone cells behind. X-ray taken later in both of these cases at a period of six months and of two years, respectively, showed no change in either of these cases. It is thought possible that the growth of such small bony foci may tend later to diminish the apparent good result. (Fig. 6.)

*Prognosis.*—The prognosis in fractures of the tubercle of the scaphoid as shown in these two cases and in many other case reports is usually good. In this type of bony fracture union is to be expected. The prognosis in fractures of the body of the scaphoid is, however, quite a doubtful matter. Increasingly it has been brought home to surgeons that the disability resulting from this injury may be a major one. In this small series more than 50 per cent. of the cases are termed chronic, due to failure of early recognition and treatment of the condition. The recent or acute cases were mostly in firemen who, on account of competent medical supervision, sought advice very

soon after their injury. The favorable results of this small group of cases, functionally and symptomatically, surprised the writer as they were quite contrary to what is usually expected. The follow-up X-ray of three out of six acute or recent fractures of the body of the scaphoid showed apparent bony union two to two and one-half years later after their injury. This high percentage of bony union, if one judges by other case reports, is unusual.
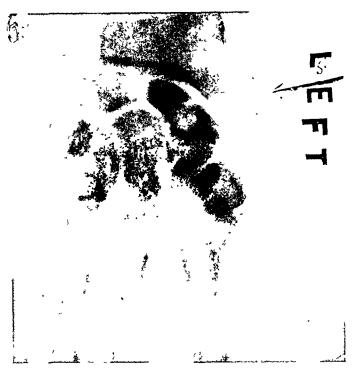


FIG. 5.—Acute case of fracture with adequate treatment that was a clinical failure. The large central shadow at operation was not found to be a cyst, although the X-ray is suggestive. This patient's pain was relieved by removal of both fragments, but his function and power were not improved. The X-ray picture simulates that described under the title of Traumatic Osteo-Porosis of the Carpal Bones. The operative finding did not bear this out.

The failure of bony union in fractures of the scaphoid has led to much conjecture, the ascribed causes varying from the deleterious effect of the synovial secretion on osteogenesis to the more understandable reason of faulty nutrition following the complete interruption of the fine arterial branches supplying this bone. Failure to protect these fine vessels by early and adequate immobilization is believed, by some, to be one of the principal factors in causing failure of bony union. Speed has stressed repeatedly the uniformly poor results in this fracture. He states that he has seen bony union only in one case, that of a young boy. Blau and Graniers have reported almost complete disability in seven out of twenty-one soldier cases, in their separate reports. They stress that fractures of this type uniformly offer a very poor prognosis. We feel, however, that the relatively high percentage of bony union in our acute cases should awaken a sense of more hopeful prognosis. The tendency to too early operative treatment should be discouraged.

With the excellent X-ray facilities at our disposal there can be no argument against the more routine use of this instrument in all cases of severe wrist injury. If an X-ray is not immediately obtainable it is wiser to suspect fracture and treat these cases accordingly. Bony union is possible, but it is improbable except in extremely favorable cases. The usual opinion that bony union occurs rarely, must not prevent one from taking the earliest adequate, protective measures. Experimentally in dogs, Johnson has shown "that while bone repair does take place it is less active than in

other bones. The zone of repair is less extensive and the fracture hyalin cartilage is healed by fibrous tissue." Also Adams and Leonard report a chronic case of fracture with non-union treated by a bone graft from the tibia. It was shown six months later that partial bony union had taken place and that the patient. a prize fighter, was able to strike blows without feeling any resultant pain. The prognosis in cases of recent fracture that fail to get bony union, pro-vided they get early diag-nosis and treatment, is symptomatically and functionally better than the X-ray appearance of the wrist would lead to believe. This is shown by the follow-up X-rays of our ununited recent cases taken two to eight years later. The X-ray appear-ance would lead one to suspect results much poorer than were ob-tained. By illustration, one patient. a physician, suffered a fracture of the body of the scaphoid about eight years ago. He was immobilized for six weeks at the time of in-jury. Follow-up X-ray shows failure of bony union with marked change in each fragment. There is also evidence present of osteoarthritis adjacent to his fracture. In spite of this dubious X-ray the



Fig. 6.—X-ray taken after removal of ununited fragments of fractured scaphoid. Four small bony deposits are shown probable in the surrounding capsule. Following X-ray taken six months later showed all but one to have disappeared. These deposits are possibly left behind after the removal of the adherent distal frag-ments

symptomatic and functional result is very good. Possibly in these cases instead of showing lack of bony union there is fibrous union.

*Chronic Cases.*—The outlook of these cases is unfavorable. There is usually non-union of the fragments with bony degeneration and adjacent osteo-arthritic changes. Pain and disability usually attend this result. Operative treatment is indicated in selected cases.

Chronic cases attended by pain as the most prominent symptom are the type most benefited by operation. The relief of pain is early and as a rule

complete. We are not impressed with improvement in function in these cases after removal of the scaphoid fragments. Most of our cases showed either very little or no improvement in function after operation.

The question of whether to remove one fragment as was suggested by Codman, or to remove all as advocated by Hirsch, Speed and others, seems to be adequately answered in favor of the latter slightly more difficult procedure, in view of the continuous pathological changes in the retained fragments that may later give rise to symptoms. The adherence of the distal larger fragment to its surrounding ligaments makes its removal at times distinctly more difficult than the free intra-articular fragment.

## CONCLUSIONS

1. Patients with fracture of the tubercle of the scaphoid obtain as a rule favorable results.

2. Early recognition and adequate treatment offer the only chance for bony union in fracture of the body of the bone.

3. Favorable results in fracture of the body of the scaphoid may be obtained in cases which are recognized and treated in the acute stage, although bony union may not be obtained.

4. The chronic cases are unusually the unrecognized ones.

5. Certain chronic cases, especially in people of sedentary occupations, have so little pain and disability that they are best let alone.

6. Chronic cases with persistent pain offer the best results to operation.

7. Function or wrist power may not be improved in the chronic cases by operation.

8. The patient's symptomatic or functional result cannot always be forecast by examination of the X-ray in either the early or the late cases.

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# TRANSACTIONS

## OF THE

# NEW YORK SURGICAL SOCIETY

### STATED MEETING HELD DECEMBER 12, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

## ECHINOCOCCUS CYST OF LIVER

DR. FORBES HAWKES presented a man, forty-eight years of age, born in Germany, living for the last thirteen years in the United States. His previous history was irrelevant except that in 1907, while on an Italian steamer at Naples, he had, together with many others on board, an attack of dysentery with bloody stools from dirty drinking water. He was in the Hamburg Hospital then for seven weeks, but left there apparently cured. Except for slight indigestion at times he felt perfectly well until April 20, 1925, when he was seized with upper abdominal pains and cough. His family physician then examined his chest and found some râles behind, over both bases, but these disappeared in a few days. His liver was enlarged and his temperature varied from 100-103° F. with profuse sweating. On April 29, 1925, he had a chill. No urinary symptoms. On April 30, 1925, when first seen by Doctor Hawkes, he presented a firm mass to the left of the epigastrium, which felt like an enlarged left lobe of the liver. This mass was tender. His abdomen was tympanitic. A few râles were heard over the left base posteriorly. He gave the history of having several years previously paid a large sum for an imported police dog and had often allowed this dog to lick his face. A tentative diagnosis was made of echinococcus cyst and he was referred to the Roosevelt Hospital. His blood count there was 14,000 leucocytes; 78 per cent. polymorphonuclears: No eosinophiles. X-ray of chest was negative. His temperature subsided in a few days, but the mass remained about the same. Exploratory laparotomy was done May 7, 1925. The left lobe of the liver was found greatly engorged, and projecting downward was an inflammatory elevation which was covered with only a few cobwebby adhesions. The other organs in the vicinity seemed normal. It was deemed unsafe to open this collection until more adhesions had formed so a gauze strip was placed around the inflammatory elevation. An aspirating needle was passed into the liver for about three inches through a markedly thickened liver area, withdrawing several drops of whitish pus. The pathological report on this pus was "pure colon bacillus cultures. No hooklets." May 11, 1925, the collection was opened, revealing hundreds of echinococcus cysts. An attempt to enucleate the sac was followed by such profuse bleeding that this was given up and the wound packed with plain gauze. There was some shock following this operation, but he quickly rallied. The next day the packing in the cyst cavity was removed and many cysts started to come out. The cavity was then irrigated with a solution of tincture of iodine 1-100 (1%) in order to kill the smaller cysts within the sac. This irrigation was done daily and hundreds of small cysts were washed out in this way, deeply stained with the iodine. At the end of six days the cavity held about six ounces and a rubber tube was introduced in order to prevent the mouth from closing. June 16 irrigation floated out what

seemed to be a portion of main cyst wall, deeply stained. June 26 two similar bodies floated out and July 20 a large and heavy piece appeared followed by smaller ones. The last ones to appear were about August 15. The tube was then shortened gradually so that by November 6 the sinus was only an inch deep. The tube was then left out, the sinus closing November 13. He had regained his weight to 145 pounds. He stayed perfectly well then for almost three years, until this summer when he was attacked while abroad with pains in the region of the old cyst. Through an opening made in the old scar was extracted what was probably the remains of the old cyst wall. Four or five days after this he was seized with sharp pains over the gall-bladder region and in the back with jaundice. An acutely suppurating gall-bladder without stones was removed. He made an excellent recovery and seems in perfect health now.

*Pathological report* on specimens removed May 11, 1925. The specimen consists of a basin filled with small cysts, blood, and débris. The cysts vary in size from small objects a few millimetres in diameter to larger ones five centimetres in diameter. Besides these there are some collapsed remnants of cysts that must have been ten centimetres in diameter before their contents were lost. The mass of the specimen with the blood strained out just fills a quart jar and a rough estimate puts the number of cysts, two centimeters in diameter or over, at about one hundred. The smaller cysts and collapsed envelopes appear to be innumerable. The smaller cysts are thin walled, colorless, quite transparent and filled with a perfectly clear fluid. The larger ones show a slight opacity over part of the circle. Finally, in the still larger ones, the internal surface shows definite granular areas and even cauliflower-like projections of tissue, one centimetre in height and several in diameter.

The sections of the walls of these small cysts show merely faintly striated pink-staining glutinous material without evidence of budding daughter cysts of scolices. In a few places the margin of the section is covered by a faintly granular material containing blood cells and leucocytes.

## ECHINOCOCCUS CYST OF KIDNEY

Dr. Forbes Hawkes presented an Armenian woman, thirty-nine years of age, who had come to this country two and one-half years ago from Armenia. Her previous history was irrelevant except that four years ago while in Armenia she noticed a lump in the right upper abdomen. This lump gave her no pain, but grew slowly in size. The family had kept a dog in Armenia and later information revealed the fact that owing to their poverty it was customary with them, as with many others, to collect ordinary grasses from the fields for food. This patient was referred to Doctor Hawkes by Dr. J. Dearden November 17, 1927. She then presented a roundish tumor just below the lower edge of an enlarged liver, roughly three inches in diameter, not tender, dull to percussion. Urine negative except for a few white blood cells. Blood count, 12,000; white blood cells; 70 per cent. polymorphonuclears; 23 per cent lymphocytes; 6 per cent. eosinophiles; 1 per cent. basophiles.

X-ray films of chest showed no evidence of any metastatic processes in lungs or pleura. Films of abdomen showed a large mass in upper right abdomen continuous with liver shadow; the appearance being one of a very definitely enlarged liver. The right kidney was obscured either by the liver shadow or by involvement of the mass. The right diaphragm was not higher than normal. The lower border of the mass extended down to the fourth lumbar vertebra on the right side. There was no evidence of any change in the spine or the ribs.

At operation at the Fifth Avenue Hospital November. 25, 1927, a very large right kidney mass was found, the echinococcus cyst occupying about nine-tenths of the tumor. Very hard adhesions bound it to the liver above and to the cellular tissues behind. The vessels at the hilus of the kidney were small and the ureter hardly recognizable as such. No cysts were felt in the liver. The gall-bladder was normal. The spleen did not feel cystic. Left kidney normal. The structures in the female pelvis felt normal. The tumor was too large a one to admit of removal through a posterior incision so that an abdominal nephrectomy was performed. with a cigarette drain to Morrison's pouch. Following the operation the urinary output was adequate. There was, however, more bleeding from the old adhesions than the drain would take care of. This resulted in a deep collection of blood which broke down and was evacuated through a lumbar incision about three weeks after the original operation. She then went on to uneventful recovery. She has had no further abdominal or renal symptoms of note. The pathological report is as follows:

*Macroscopical Examination.—A.* Separate piece of tissue, thought to be from one adrenal, is two centimetres long, one millimetre thick, one centimetre broad, yellow in appearance and on section resembles an atrophied adrenal. *B.* Specimen has appearance of a cyst measuring 17 x 15 x 10 centimetres. At one edge there is the structure of a kidney which is ten centimetres long, the cyst appearing to have developed in its capsule. On opening the cyst the kidney itself shows a cyst 5x4½ centimetres extending from the hylum outward in what would be the region of the pelvis with an atrophied kidney on either pole. This cyst is filled with small grape-like bodies, which are translucent bodies. The appearance of these cysts is typical of echinococcus.

*Microscopical Examination.*—Tissue from surface of cyst shows the structure of the adrenal. Section through the wall of the two cysts and the remains of the kidney shows atrophy of the kidney tubules and a very marked cellular infiltration which is made up almost entirely of eosinophiles. Sections of the cyst wall show dense fibrous tissue which in the case of some of the smaller cysts shows the characteristic lamination. Examination of the unstained cysts shows the laminated cyst wall and within the cyst many scolices, also cholesterin crystals lying free in the fluid.

DR. WALTER A. SHERWOOD stated that several years ago he presented before the society two cases of echinococcus cyst of the liver which he had observed and cared for in the Brooklyn Hospital. Two other cases were later observed since which time he had never seen another. The interesting part of these four cases was that in each it was thought that the etiology could be traced to the association of the patient with sheep dogs. All four patients were foreigners, one an Italian, two were Greeks, and one an Armenian, and in each, by careful questioning, it was found that they came from families closely associated with sheep herders and all had lived with or slept in the same room with sheep dogs, which is supposed to be the most common means of the transfer of echinococcus parasites from dog to man.

All were typical cases and a radical operation was done in each in one or more stages. Convalescence in two cases was very stormy. In these there were many complications: two developed empyema of the thorax and all but one required two or more secondary operations before they were well. Up to that time this was the only type of liver cyst he had seen.

Recently, however, he operated on a man sixty years of age who had been under his observation for a long period of time because of digestive disturbances. In spite of careful study they were unable to make a diagnosis, but finally the patient appeared with a large mass in the abdomen the size of a huge watermelon, complained of loss of weight and increased digestive disturbances. Examination before operation showed a large cystic tumor occupying the entire right upper and mid abdomen with the stomach crowded well over to the left side. At operation the cyst was found to have had its origin in the region of the falciform ligament of the liver. It contained nine quarts of clear yellow fluid, which on examination showed nothing but a trace of albumin, specific gravity of 1015 and no parasites of any sort. This cyst occupied the subdiaphragmatic space, was contiguous with the liver, pushing it downward and to the left, the right kidney downward toward the mid-line and crowded the stomach well over to the left side. The cyst was drained by means of a trochar and canula, and part of the sac wall was removed and then brought up into the upper angle of the abdominal wound and sutured there. A large rubber tube and gauze packing were introduced. The remainder of the cyst wall was covered with large tortuous veins and it was felt that any attempt to completely remove the sac might result in severe hæmorrhage. The liver itself seemed entirely normal.

Doctor Sherwood asked if any other member of the society had encountered this type of liver cyst.

## COMMON-DUCT STONES

Dr. Kirby Dwight presented a woman, forty years of age, who entered the Roosevelt Hospital June 28, 1926, with a history of repeated attacks of gall-stone colic. Her history of abdominal pain went back twenty years: always in the right upper quadrant, colicky in character, at times very severe. She would have attacks every four months. No jaundice. Between the attacks she would be well except for gaseous eructations. For three weeks before admission she had had repeated attacks of this pain, very severe, brought on by eating. The pain began in the right side and radiated to the back.

On admission she had a temperature of 101.8° F. with a white count of 9500, polynuclears 72 per cent. In two days her temperature was normal. Physical examination was essentially negative, no tenderness or masses in the abdomen, no jaundice.

A few days after admission jaundice began to develop. It deepened, and a few days before operation the icterus index was 86. Blood clotting time nine minutes. A gall-bladder visualization test after phthalein dye failed to show the gall-bladder. After the administration of fifty cubic centimetres of 1 per cent. calcium chloride solution intravenously on three successive days she was operated upon July 17.

The gall-bladder was small; its walls thickened. It was very closely adherent at its fundus to the first part of the duodenum. It contained two calculi, round, mottled, of the mulberry type; one about one centimetre in diameter, the other about seven millimetres. There were a few irregular facets on them. The larger one was in a little pocket at the fundus and was

apparently just about to ulcerate through into the duodenum at the site of the dense adhesion. The other was loose in the gall-bladder. The cystic duct was much dilated, enough to admit a finger, and was very short. The common duct was greatly dilated due to a large calculus, about two centimetres in diameter, which was impacted in it behind the border of the duodenum. The hepatic ducts were dilated. They were explored with probe and finger, but no calculi found. The common duct distal to the stone was normal and a probe was passed through into the duodenum.

The incision was a right rectus one, with reflection of the rectus muscle outward. The adhesion between the fundus of the gall-bladder and the duodenum was so dense that separation could be accomplished only by amputating the tip of the gall-bladder. The bit of mucous membrane left attached to the surface of the duodenum was curetted away. The gall-bladder was evacuated and a cholecystostomy done. Then the descending duodenum was mobilized and access gained to the common duct at the site of the calculus. The duct was opened, the calculus removed and the duct closed again, by the Mayo method, with a gauze wick tied over the suture line. This drain, covered with rubber tissue, and the tube from the gall-bladder were brought out through a puncture opening in the rectus muscle.

For two days following operation the patient had a stormy time, but recovery was excellent after that. She was discharged on the thirtieth post-operative day.

For five months the patient was free from symptoms. Then, January 11, 1927, she had a severe attack of colic and returned to the hospital the next day. She was jaundiced, with an icterus index of 32; clotting time of nine and one-half minutes. Calcium chloride was administered as before and January 24 she was reoperated upon. The first part of the duodenum was buried in adhesions and was not seen. The gall-bladder was contracted. No calculi could be felt in it. The common duct was dilated, but not so much so as at the time of the previous operation. When it was opened the finger could not be introduced into it. There was a small calculus of the mulberry type about seven millimetres in diameter, impacted in the papilla of Vater, or just proximal to it; its surface was mottled and irregular, with several facets which appeared to be old; probably a calculus which was present, but not found at the time of the first operation. A probe was passed into the hepatic ducts, but no further calculi were found. The pancreas was normal. It was found impossible to work the stone up into a more accessible portion of the common duct, so a transduodenal choledochotomy was done, and the calculus extracted, enlarging the opening in the papilla of Vater. The anterior wall of the duodenum was closed with three layers of tanned gut. The common duct was drained through the incision made in it for exploration.

These procedures had taken so much time that it was not considered wise to remove the gall-bladder.

The patient was very sick for about three days after operation, but then her general condition began to improve. The local condition, however, began to look serious. There was a profuse discharge through and around the drain to the common duct, and the drainage contained not only bile, but duodenal contents. There was a great deal of skin irritation and the discharge had a pungent odor.

By the seventh post-operative day there was evidently a duodenal fistula in full swing, with a profuse irritating discharge digesting the abdominal wall. This did not last long, however. In a few more days the discharge

began to decrease in amount, and by the fifteenth day the discharge was moderate in amount and non-irritating; and the wound began to heal.

This then was not a true duodenal fistula, but a back flow of duodenal contents up the common duct and out through the drainage tract. Later, by some mechanism not quite clear, this back flow stopped and the drainage tract began to heal, and the patient was discharged on the twenty-seventh post-operative day.

Since then she has had no further attacks of pain or any other symptoms referable to the bile tract, but in January, 1928, she began to have the classical symptoms of diabetes. In April she returned to the hospital for examination and was found to have a glycosuria and a blood sugar of .20.

This patient is shown as a case of residual common-duct stone after a choledocholithotomy. This calculus, which remained after a very thorough exploration of the common and hepatic ducts, was probably lying in one of the distal hepatic ducts, too far up and around too many curves to be found by finger or probe. As Doctors Counseller and McIndoe have shown with their corrosion specimens of the liver, in common-duct obstructions there is a wide dilatation of all the radicles of the hepatic ducts. With a patient in the supine position on the operating table it would be an easy matter for a small round stone to gravitate into one of the more distant branches and thus be out of reach of finger or probe.

She is also shown on account of the very interesting pseudoduodenal fistula with its spontaneous subsidence. It was evidently a mistake to drain the common duct after the sphincter of Oddi had been incised.

DR. ALLEN O. WHIPPLE called attention to the cases in which the stone in the dilated common duct could be felt, but in attempts to remove it the stone was found to disappear in the upper part of the duct. In order to meet such an emergency he had found it of real value to press on the right and left lobes of the liver as a manœuvre to bring the stone down into the lower part of the duct system where it could be removed by forceps. In his experience this manœuvre had proved effective where irrigation and manipulations of the forceps had failed to locate the stone.

## GUNSHOT WOUND PERFORATING ASCENDING COLON

DR. KIRBY DWIGHT presented a man, thirty-two years of age, who was brought to the Roosevelt Hospital August 6, 1922, suffering from a gunshot wound of the abdomen. He had been shot with a revolver one hour before admission. He was in moderate shock, with a pulse of 120, and was doubled up in acute pain. His abdomen was scaphoid in shape, and was rigid. The wound of entrance was in the right lower quadrant at about the level of the anterior superior spine; there was no wound of exit.

He was operated upon at once, using gas-ether anæsthesia. On opening the abdomen through a right rectus incision, a large amount of blood was found in the peritoneal cavity; but no gas or intestinal contents were encountered until some loops of small intestine were drawn away from the ascending colon, against which they were pressed; then there was a gush of gas and of liquid fæcal matter into the peritoneal cavity. There were no adhesions between these loops of small intestine and the colon; they merely lay adjacent to it and yet they had prevented any gross soiling of the peritoneum. There were four holes in the ascending colon and cæcum.

two on the anterior surface, one on the medial and one on the posterior. The blood supply of the gut was compromised by injury to the branches of the right colic blood vessels.

Although the patient's condition was none too good, a resection was decided upon. The cæcum, ascending colon, and hepatic flexure were mobilized. The terminal ileum was divided between clamps, the proximal end was inverted and a side-to-side anastomosis was made to the middle of the transverse colon. The patient was doing badly; the anastomosis was a hasty one and not secure against leakage if there should be any distention of the gut at its site. Consequently the gut to be resected, after it was completely freed, was brought out at the upper angle of the wound, leaving in the abdomen only about two inches of transverse colon proximal to the enterocolostomy. It was sutured in place and the wound was closed around it.

The purpose of this procedure was to save the time that would have been consumed in closing the stump of the transverse colon; and also to minimize the chance of leakage from the anastomosis. The colostomy stoma was only about three inches from the enterocolostomy and so there could not be any pressure inside the gut at that point. There was very little discharge of fæcal matter through this colostomy opening; nearly all of it, for some reason, passing the other way on entering the transverse colon.

The patient recovered from the shock of the injury and of the operation. He did not develop peritonitis or secondary peritoneal abscesses, as he should have done, considering the amount of contamination at the time of operation; but his recovery was delayed by the development of an abscess around the bullet, which had lodged in the erector spinæ muscle. This abscess extended downward between the psoas and iliacus muscles and was found with some difficulty. A pneumonia, which came on a few days after his temperature had returned to normal following the drainage of the abscess, still further delayed his recovery.

An attempt to close the colostomy stoma was made October 6. It was partially successful. Another attempt was made a month later and this time we succeeded.

The man has been well, has had no diarrhœa or other digestive symptoms. There is a moderate ventral hernia, but it does not seem to bother him much.

## ILEOCÆCAL INTUSSUSCEPTION DUE TO POLYP

Dr. Harold E. Santee presented a man, sixty-two years of age, who was admitted to the Bellevue Hospital February 19, 1927. He had suffered for the preceding two weeks from cramp-like pain in the abdomen. At the onset this cramp-like pain was accompanied by nausea and vomiting, followed quickly by a profuse diarrhœa. After one week, however, nausea and vomiting ceased and the bowels became constipated, so that enemas were necessary. During the entire two weeks cramp-like pain without localization persisted and marked anorexia succeeded the vomiting.

His previous history showed nothing relevant to the present condition—in fact, the present attack followed a long period of particularly good health and good feeling.

His abdomen was lax walled, soft, with no distention. In the right lumbar gutter could be palpated a smooth, freely movable, slightly tender, fusiform mass extending up the gutter almost to the costal margin. Below this could be palpated a distended segment of bowel assumed to be cæcum. Temperature, pulse and respirations were normal. A stool examination on two occasions was negative for blood. A barium enema showed a marked delay in the passage of the mixture beyond the hepatic flexure. However, the

hepatic flexure finally filled out regularly. During observation for one week in the hospital, the patient continued to have intermittent attacks of cramp-like pain and distention which, however, were much relieved by enemata and colon irrigations. During this time, the tumor mass was always present, but seemed to vary somewhat in size and consistency.

March 2, 1927. the abdomen was opened through a right lower rectus incision. The mass in the right lower quadrant was first interpreted as a herniation of the terminal ileum into a retrocæcal fossa because the finger could be so easily passed about the intussuscepted gut. The nature of the lesion was quickly recognized, however, and by gentle traction the ileum could be easily delivered backward. Only a thin layer of fibrin covered it and circulation was excellent. About eight inches were intussuscepted. On examination for a possible cause for the intussusception there could be palpated within the lumen of the ileum about eight inches from the ileocæcal valve a soft, "meaty" feeling tumor about the size of the thumb. This could be milked back and forth within the lumen of the gut for about four inches. Fixation to the wall was assumed and a longitudinal incision in the ileum showed a pedunculated, soft, polypoid mass such as had been felt through the wall with a small pedicle attached to the mesenteric side of the gut. This was ligated and the mass removed. The ileum was then closed with a double row of fine chromic sutures and the apparent cause of the intussusception having been removed, no further procedure was done. The wound was closed in layers without drainage.

The patient made a slow but satisfactory convalescence. A small colon bacillus superficial abscess developed in the wound and was opened on the eighth day. The wound was then Dakinized down to the fascia. A cystitis was troublesome for two weeks. On discharge April 15, 1927, he was again in excellent general condition and has remained so since.

Pathological examination of the growth by Doctor Symmers demonstrated a mucous polyp.

## ILEOCÆCAL INTUSSUSCEPTION DUE TO CARCINOMA

Dr. Harold E. Santee presented a man. forty-nine years of age, who was admitted to the Bellevue Hospital January 24, 1928. His previous history stated that he had been diagnosed as having pulmonary tuberculosis in 1923; had been in bed for seven weeks with a pleurisy with effusion in 1926; and had suffered from dyspnœa on exertion for one year previous to admission. For ten months prior to admission this patient had been troubled with cramp-like pain across the lower abdomen, particularly after each bowel movement. Between such attacks, slight "cramps" might occur or there might be complete cessation of pain, but as time elapsed mild "cramps" became more frequent and were felt particularly in the right lower quadrant of the abdomen. Two months before admission a sharp attack of diarrhœa with bowel movements almost every hour lasted for two days. Some vomiting occurred at this time. No blood or mucus or tarry stools were ever noted. Coincident with these local symptoms the patient had gradually lost seventeen pounds, had noticed an increasing dyspnœa and an increasing pallor and weakness.

Examination showed a fairly thin, obviously anæmic-looking individual, apparently chronically ill, weighing 116 pounds. The chest showed a localized area at the right base where fine crepitant râles were constantly heard. The abdomen was soft and easily palpated. In the right lower quadrant could be felt at times a firm, movable, slightly tender mass about two inches in breadth and four inches in length. At times this mass would almost disap-

pear and at other times became larger. It not only varied markedly in size but also in position and under manipulation could be pushed easily into the left lower quadrant, over to the left of the umbilicus, or almost under the right costal margin. The patient's temperature, pulse and respirations were normal. The urine was repeatedly negative. The stools under dietetic restrictions showed blood by the guaiac test. The Wassermann test was negative. Blood examination showed hæmoglobin 63 per cent., red blood cells 3,700,000, white blood cells 9000 with polymorphonuclears of 67 per cent., lymphocytes 33 per cent. Two weeks later, hæmoglobin and red blood cells were somewhat further reduced. Röntgenological study showed fibroid changes at the left apex and no organic change in stomach or duodenum. Following administration of a barium enema, the colon examination revealed an irregular filling defect involving the cæcum, suggesting the presence of malignant infiltration. Following a clinical conference on the case, a second bismuth meal was given and it appeared to pass normally through the large bowel. A second barium enema confirmed the filling defect involving the cæcum with the suggestion that it might be due to tumor formation and the possibility that the defect noted might be the result of an ileocæcal intussusception.

Operation on February 27, 1928, was done under spinal anæsthesia until the sew-up, when some gas-oxygen was used. Exploration through a lower right rectus incision revealed a cæcum and terminal ileum intussuscepting into the ascending colon with adhesions and beginning peritonealization of the margins of the intussusception. The terminal ileum proximal to the intussusception was bound down to the posterior wall of the pelvis and its brim by an abnormal fold of peritoneum, apparently developmental in origin rather than pathological. Within the intussusception was a hard, rounded, nodular mass the size of a small orange. One enlarged gland was found on the posterior wall of the abdomen just lateral to the cæcum.

The entire mass was very mobile, confirming the pre-operative clinical findings. Terminal ileum, cæcum and ascending colon were mobilized and resected. The stumps were closed and inverted and the terminal ileum was then anastomosed to the transverse colon side to side as a gun barrel anastomosis. A cigarette drain was placed through a stab wound into the right lower quadrant and the right rectus wound closed with a small rubber dam drain down to the fascia. A moderate amount of purulent drainage showed at the site of both drains. Temperature was normal, however, after five days and convalescence was smooth and progressive. A moderate diarrhœa showed from the fifth to the seventh days, but was controlled with tincture of opium. The patient left the hospital March 30, 1928, feeling stronger and better than prior to the operation and with his wounds fully healed. Six weeks after discharge from the hospital he had gained twenty-three pounds and since then has continued to add to his weight.

The pathological examination demonstrated the characteristics of adenocarcinoma.

DR. EDWARD R. CUNNIFFE related the details presented by a woman, seventy-one years of age, who was admitted to Fordham Hospital where a diagnosis of acute intestinal obstruction was made. At operation Doctor Cunniffe found an intussusception of the sigmoid which was easily reduced. The colon was very carefully palpated for a tumor, since a malignancy was suspected, but no evidence was found. The abdomen was closed and the patient did well. After an uneventful convalescence, she was discharged.

Two years laters she returned to the hospital with a large mass in the sigmoid. At reoperation a carcinoma of the sigmoid, which also involved a loop of the small intestine, was discovered. The small intestine was resected.

Then the entire mass, including the growth in the small intestine, was brought through the abdomen—a first stage Mikulicz operation having been performed. Eventually this was successfully completed. Three years later, at the age of seventy-six, the patient died with a recurrence in the wound.

DR. WALTER A. SHERWOOD stated that in the August number, 1927, of *Surgical Clinics of North America* he had reported three cases of intussusception associated with and apparently caused by neoplasms in the neighborhood of the ileocæcal valve. One case, in an infant, proved to be a simple fibroma, the second a lymphosarcoma, and the third a carcinoma of the cæcum just distal to the ileocæcal valve.

These three experiences had impressed him with the importance of a careful search for new growths in all cases of intussusception involving the ileocæcal region.

DR. JOHN DOUGLAS said that the occurrence of intussusception in adults is recognized as usually being due to some form of tumor which is the apex of the intussusception. The only case of intussusception in an adult which he has ever operated upon was a case of sarcoma of the small intestine which he presented before this society in 1916. In that case there was sarcoma of the ileum and a constant effort of the intestine to intussuscept was visible. Visible peristalsis was present and the tumor went up and down out of the pelvis. It was quite easy to feel and then it would disappear, as in Doctor Santee's case. He saw one case of intussusception of the small intestine in an adult within the last two weeks at St. Luke's Hospital operated on by another surgeon in which there was no sign of a tumor in the intestine which could be given as the cause for the intussusception. Doctor Douglas said he had found there was nothing more difficult to deal with than the necessity of giving a general anæsthetic in a case of acute intestinal obstruction. Most of them must be done under local or spinal anæsthesia and in some of these cases in the face of a great deal of distention, where a long operation is going to be necessary, and spinal anæsthesia will not last, it becomes necessary to give a general anæsthesia with the danger of vomiting in the presence of acute obstruction. He recently met with this problem. The man had an acute obstruction, due to a strangulated hernia, which had been present for several days. He had fæcal vomiting and his stomach filled rapidly. He felt he had to give this man a general anæsthetic. It then occurred to him to use a Levine tube, which was put through the nostril and emptied the stomach before the operation. He left the Levine tube in this man's stomach during anæsthesia and the patient continued to drain a considerable amount of fæcal vomitus throughout the operation. The tube was left in for twenty-four hours after operation and the patient did not vomit. Doctor Douglas would like to recommend this method.

DOCTOR PARSONS said that he had shown two cases, one before this society, and one before the Academy, of intussusception caused by benign intestinal tumors. One woman had ileocæcal intussusception due to a large lipoma. She was so fat that palpation of any mass intra-abdominally would

have been a physical impossibility. In the other woman, in the early fifties, it was due to a fibroma arising from the antimesenteric border near the middle of the ileum. There was so much distention no mass was palpable. In Doctor Santee's cases the masses were palpable. This is explainable by the fact that a certain amount of gas was passed so that the tumor was not marked by distended coils of the intestine.

## PNEUMOCOCCUS SUBCUTANEOUS ABSCESSES

DR. HAROLD E. SANTEE said that pneumococcus subcutaneous abscesses are apparently rare. Report of them in the literature is unusual. Their rarity, however, is probably more apparent than real and they would probably be found more frequently were sufficient bacteriological investigation made. Personally he never saw one until two years ago.

The patient had been through a severe pulmonary pneumococcus infection of Type I and had received numerous camphor in oil injections. At the site of such injections in deltoid and thigh regions five abscesses developed successively; subcutaneously in four, beneath the fascia lata in one. These developed between the tenth and eighteenth days following the onset of his pulmonary infection; and approximately three weeks after the onset of this same infection, the patient was operated on for an empyema of the right chest which also showed a Type I pneumococcus. He made an excellent recovery.

No similar cases were encountered by him until last winter, when three additional patients were seen with pneumococcus abscesses.

On February 11, 1928, L. S., thirteen years of age, was seen at his home. He had just been brought home from his school where a large number of students had been taken ill with sore throats, tracheitis, bronchitis and some pneumonias. His illness began without particular cough or respiratory irritation, but with malaise, gradually increasing temperature, and soreness in the right pectoral region, near the axilla. On arriving home he was acutely ill with a temperature ranging from 101° to 103°, pulse 110, respirations normal. There was slight cough, but no pulmonary signs could be made out by the attending pediatrician. His physical examination was negative except for the right pectoral and axillary region. Here there was an obvious swelling involving the outer pectoral region for a distance of about three inches with tenderness, a slight feeling of bogginess and an accompanying acute adenitis of the chain of glands underneath the edge of the pectoralis major, extending upward into the axilla. He was watched for two days with warm wet dressings on this region and then incised. An abscess pocket which fanned out from the anterior axilla in a thin layer in front of the pectoralis major, underneath the pectoralis major and upward into anterior axillary region was drained. The glands were swollen, juicy and œdematous, well matted together in the lower axilla, but not broken down apparently. The pus was thick, creamy and without odor. Culture showed a streptococcus mucosus capsulatus or pneumococcus Type III. Convalescence was uneventful. No history of local trauma could ever be elicited in this case which was probably of respiratory tract origin.

Case three was that of a woman, thirty-nine years of age, who was admitted to the Second Medical Division at Bellevue Hospital February 13, 1928. Five weeks previously she was at full term when she became acutely

ill with a chill, fever, cough and pain in the right chest. Her sixth child was born the following day. Following this rusty sputum and high fever continued for ten days, then she was better, but not well. She was admitted to the hospital because of delayed resolution of a right lower lobe penumonia. One week after admission, or six weeks after the onset of her pneumonia, she showed a painful, tender swelling over the left rectus, just below the costal margin. This rapidly showed fluctuation. To exclude possible communication with her disease of the right lower chest, some pus was aspirated and a lipiodol injection made into the abscess. An X-ray taken showed complete localization with no communication into the thoracic cavity. Culture showed a pure pneumococcus Type I. Incision and drainage showed a well walled-off abscess in the subcutaneous tissues. No history of trauma either spontaneous or manual during delivery of her baby seems to account for the localization in this case.

The fourth case was in a man, forty-five years of age, who was admitted to Bellevue Hospital, February 28, 1928. He ran a typical left lobar pneumonia showing a Type I pneumococcus. From his history the onset of his illness dated six days before admission. Three days before admission he noticed a painful swelling in the region of the first metatarsophalangeal joint on the dorsum of the right foot. During his pneumonia this area on the right foot gradually extended and showed fluctuation. This was twice aspirated and showed a Type I pneumococcus. At the subsidence of the pneumonia, but when patient was still very ill, this abscess of the dorsum of the foot was incised and drained under spinal anæsthesia. The abscess was subcutaneous, but considerable cellulitic reaction surrounded it. No communication with surrounding structures was made out. This patient, like the first patient, developed an empyema. Thoracotomy and rib resection were done and he was discharged from the hospital on April 17, 1928, with his foot completely healed and his chest practically healed.

## CHRONIC CYSTIC MASTITIS. EXPERIMENTAL PRODUCTION

Dr. Otto Pickhardt read a paper with the above title.

Dr. DeWitt Stetten reported his personal experience with chronic cystic mastitis, of which he has seen a considerable number of cases, largely among private patients whom he has been able to follow closely. As yet he has seen no case treated primarily for a chronic cystic mastitis which has become carcinomatous. In the past ten years he has seen over fifty cases, most of which have been treated by conservative measures, namely, the excision of the cystic mass, and he recalls only two cases in which a simple mastectomy was done. In those cases in which the cyst alone was excised the microscopic examination of the surrounding breast tissue invariably showed further chronic cystic mastitis. A number of the cases showed recurrences of the disease, requiring in many instances two or more operations, but microscopic findings never showed malignancy. It is quite true that in almost all cases of carcinoma, chronic cystic mastitis will also be found, but this is readily accounted for by the fact that the ages at which the two diseases are prevalent is about the same.

Dr. William B. Parsons reported two cases of the group when the diagnosis between chronic cystic mastitis and a carcinoma is doubtful. In both these cases frozen section was done at the time of operation and the diagnosis

of cystic mastitis was made and simple mastectomy was therefore done. These cases were operated upon between two and three years ago and in both cases there has been a recurrence of swelling, or rather a hard swelling has appeared in the axilla. Operation was urged in both cases, but both refused. One has been lost track of. Recently the other returned with an ulcerating mass in the axilla. A specimen showed adenocarcinoma. At the original operation in both cases there was perforation of the duct epithelium, but no invasion was found at any point.

Dr. James N. Worcester said that some time ago he had sectioned a large number of breasts at Bellevue Hospital which had definite carcinoma and that practically all of these showed an accompanying chronic cystic mastitis, and in the areas of chronic cystic mastitis were sections which were very suspicious of early carcinoma.

These two lesions he thought have an intimate association.

<center>STATED MEETING HELD JANUARY 9, 1929</center>

<center>The President, Dr. Frank S. Mathews, in the Chair</center>

<center>LARGE GASTRIC ULCER, SUBTOTAL GASTRECTOMY</center>

Dr. Richard Lewisohn presented a man, sixty years of age, who was admitted to Mount Sinai Hospital November 26, 1926, with the following history: While lifting a heavy weight about two weeks before, he noticed a pain in the left groin. He consulted a physician who told him that he had an inguinal hernia and advised operation.

A careful study of this patient, however, after his admission to the hospital revealed that he had been suffering for the past year from epigastric pains which occurred about two hours after meals, also sour eructations. He never vomited. The pain was not relieved by bicarbonate of soda.

X-ray examination showed a large perforating ulcer of the lesser curvature, extending on to the posterior wall in the region of the reëntrant angle. An incisure was seen on the greater curvature opposite this perforation. There was no delay in gastric motility. *Diagnosis.*—Gastric ulcer.

An Ewald test meal showed free hydrochloric acid 13; total acidity 38. December 24, 1926, he was subjected to a subtotal gastrectomy with Murphy-button anastomosis. The operation was done under local anæsthesia through a five-inch mid-line incision in the epigastrium. Exploration revealed a large ulcer high up on the lesser curvature, about two inches below the cardia. This ulcer passed from the anterior wall to the posterior wall of the stomach, straddling the lesser curvature, the larger part of the ulcer occupying the posterior wall. The ulcer was about five centimetres in diameter; its edges were markedly thickened and indurated. The ulcer was densely adherent to the pancreas. There was marked œdema and hypertrophy of the gastric wall, especially in the region of the ulcer. (Fig. 1.)

On account of the high location of the ulcer and the marked inflammatory reaction in the surrounding tissues, the subtotal gastrectomy was performed in retrograde fashion. The right gastric-epiploic artery and the pyloric artery were divided and the stomach cut through just beyond the pylorus. The opening in the duodenum was closed in three layers. The gastrocolic ligament was then divided between clamps, the adhesions between the ulcer and the pancreas were separated by sharp dissection, the gastric artery was caught and the stomach was divided about one inch from the cardia. No gastric

clamps could be applied on account of the high location of the ulcer. The opening in the stomach was closed in three layers after the female part of a Murphy button had been pressed into the lumen of the stomach. A loop of jejunum was then brought up through an opening in the mesocolon, the male part of the Murphy button was introduced and both halves of the button were united after a small stab wound had been made into the posterior wall of the stomach in order to be able to push through the gastric half of the button. The abdomen was closed without drainage. *Microscopic diagnosis.*— Gastric ulcer.

The patient had a rather stormy post-operative course during the first four days after the operation. He vomited a considerable amount of blood, requiring aspiration of the stomach and lavage at frequent intervals. From the sixth day on he made a very smooth and uneventful recovery. Rehfuss test meal, taken on the day of his discharge (January 7, 1927), showed free hydrochloric acid o; total acidity 20. He has been in perfect health ever since his operation and has gained forty pounds.

Doctor Lewisohn stated that he had seen a considerable number of patients admitted to the hospital with the complaint of an i n g u i n a l hernia and referred to the service for operation of this condition, in whom a c a r e f u l study had revealed that they were suffering from a more serious trouble; namely, gastric or duodenal u l c e r. While epigastric distress may be associated with hernia, every patient complaining of a b d o m i n a l symptoms should get a careful gastro-intestinal study, as the symptoms of gastric distress in the majority of these cases are not due to the hernia, but to an intragastric lesion which requires surgical operative intervention in order to cure the patient.



Fig. 1.—Large gastric ulcer.

## SMALL GASTRIC ULCER, PARTIAL GASTRECTOMY

Doctor Lewisohn presented a man, thirty-five years of age, who was admitted to Mount Sinai Hospital November 11, 1925. He had complained of epigastric pain for the previous four weeks. The pain was not alleviated

by bicarbonate of soda. He had vomited a few times during the past three weeks and had frequent eructations and belching. No hematemesis.

The patient had had an attack like the one just described about three years previously. He had been suffering from epigastric distress more or less continuously during the last two years. Test meal showed a free hydrochloric acid of 55; total acidity, 66.

X-ray examination showed a very small projection at the region of the reëntrant angle. The projection is only three-eighths inch long. There was no residue in the stomach after six hours. This patient had been gastroscoped previous to his admission by a laryngologist. The gastroscopy showed a chronic gastritis and failed to reveal the ulcer.

Operation, November 21, 1925, under local anæsthesia of the abdominal wall. A very small penetrating ulcer with slight induration was found just at the reëntrant angle. A typical partial gastrectomy was performed with Hofmeister anastomosis. The specimen showed a very small gastric ulcer, the crater being the size of a pin head, with some induration around this tiny ulcer. (Fig. 2.) The patient made an uneventful recovery and left the hospital December 9, 1925. Ewald test meal on discharge was free hydrochloric acid 0; total acidity, 19.

DOCTOR LEWISOHN stated that he had presented these cases in order to show that both large and small gastric ulcers should be subjected to resection whenever feasible. While it might have been techni-



FIG. 2 —Distal half of stomach, showing small gastric ulcer (a).

cally easy to excise the small ulcer as presented in the second patient, experience had shown that local excision with or without gastro-enterostomy failed to give the excellent results following partial or subtotal gastrectomy for gastric ulcer.

## DUODENAL ULCER WITH MARKED PYLORIC OBSTRUCTION

DOCTOR LEWISOHN presented a man, thirty-three years of age, who was admitted to Mount Sinai Hospital October 16, 1928, upon whom he had first operated eight years previously at Beth Israel Hospital. At that time he had presented all the typical symptoms of a duodenal ulcer. However, the operation failed to reveal an ulcer in the duodenum. An appendectomy was performed and the abdomen was closed in layers.

Ever since his discharge from Beth Israel Hospital the patient had been suffering gastric distress at intervals of two to three months. During the last month his symptoms had become markedly aggravated. Constipation was very marked. He had lost fifteen pounds in the past three weeks.

A gastric lavage shortly after his admission showed that the stomach contained three quarts of fluid.

X-ray examination showed an extreme dilatation of the stomach. The

stomach descends about three inches below the crest of the ileum with the patient standing. No barium was seen to pass through the pylorus during the entire fluoroscopic observation. At the end of twenty-four hours there was still evidence of complete retention. Nothing was seen in the small or large intestine. (Fig. 3.) These findings show a complete pyloric obstruction, the exact nature of which cannot be obtained from the Röntgen examination, but is usually due to an ulcer.

Experience has shown that it is not wise to subject patients with practically complete pyloric obstruction to an immediate operation. Operative interference was therefore postponed in this case for about a week, during which time he was subjected to lavages of the stomach which were given twice daily, subcutaneous injections of saline solution and the introduction of fluid by the Murphy drip into the rectum. The repeated gastric lavages establish a better tone of the gastric musculature and induce a marked reduction in the size of the stomach.

The two-stage operation as suggested by Crile and Lilienthal should be used only in cases of extreme weakness and emaciation, as it has been our experience that partial or subtotal gastrectomy following a previous gastroenterostomy is, as a rule, a much more difficult operation than primary resection of the stomach.

The operation was performed October 25, 1928, under spinal anæsthesia supported by gas, oxygen and ether toward the end of the operation. Mid-line incision between the ensiform process and the umbilicus. The stomach was markedly enlarged and a hard, indurated ulcer was found beyond the pylorus at the posterior wall of the stomach adherent to the pancreas. A typical partial gastrectomy was performed with a Hofmeister anastomosis between the cut end of the stomach and the jejunum. The specimen showed an active ulcer on the posterior
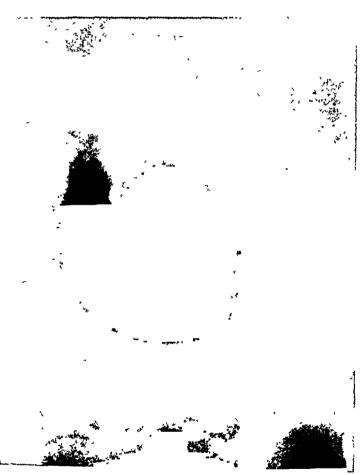


Fig. 3.—Duodenal ulcer with obstruction, showing complete retention of barium test-meal in the stomach after twenty-four hours.
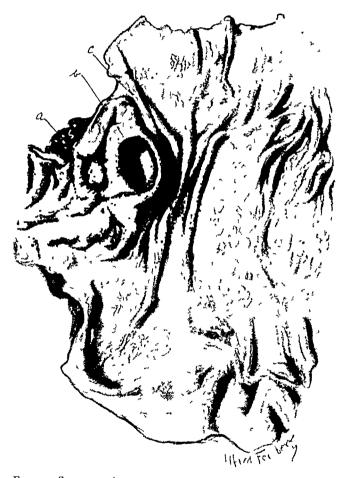
wall of the duodenum, the size of the nail of the fifth finger and a diverticulum just beyond the pylorus. There was active infection in this ulcer, the base being of a greenish color. The pylorus was markedly contracted. (Fig. 4.) The patient made an uneventful recovery and left the hospital November 13, 1928.

When seen a few days ago he was in excellent health and had gained

twenty-five pounds since the operation. The Rehfuss test meal showed free acid o; total acidity 20 during the first hour; after two and one-quarter hours' observation free hydrochloric acid was registered as 32, combined acids as 48.

Doctor Lewisohn stated that he presented this case in order to show that primary resection of ulcers is feasible in the presence of marked obstruction. It has often been stated that pyloric obstruction, especially when dealing with a healed ulcer, requires nothing else but gastro-enterostomy in order to effect a perfect and permanent cure. However, it is very often impossible to decide by palpation whether an ulcer has undergone complete healing and has formed a permanent scar, or whether it is still in an active state of infection. This patient, though he had been suffering from an ulcer for over eight years, still had an active ulcer which caused the obstructive symptoms. At the time of the previous operation this ulcer had probably undergone temporary healing and thus the palpating finger failed to find any evidence of the ulcerative process.



Fig 4—Specimen showing a duodenal ulcer (a) on the posterior wall and a diverticulum (b) just beyond the pylorus (c)

## ENDOMETRIOMA IN RECTOVAGINAL SEPTUM

Dr. Edwin Beer presented a woman, thirty-nine years of age, who was referred to him by Dr. J. Walter, who had recognized a fibroid of the uterus in September, 1920. Hysterectomy was done supravaginally May 15, 1922. The uterus contained both large and small fibroids which, on the right side, had grown into the floor of the pelvis and the broad ligaments. The left ovary was not removed. The appendix was removed at this operation.

The patient made an uneventful recovery and remained perfectly well until July 14, 1928, when she noticed some bleeding on two occasions. On examination, with the patient in the knee-chest position, through a cylindrical speculum, a polypoid, red mass about the size of a small raspberry was seen projecting from the normal mucous membrane into the posterior cul-de-sac. From this several specimens were excised. Vaginal digital examination showed

a mass between the vagina and rectum about as large as a walnut, and by rectum this could be felt directly under the mucous membrane.

The specimen excised showed, under the microscope, "typical endometrial glandular tissue". The patient was given a series of X-ray exposures with the object of producing castration of the left ovary which was still *in situ*, and indirectly controlling the endometriomatous bleeding.

Under this treatment, which was given in August, the mass, as felt by vaginal and rectal examinations, has diminished considerably; there has been no more bleeding; and on vaginal examination, through the endoscope one can still see a tiny red spot in the posterior fornix, which was coagulated with the high frequency current a little over a month ago.

In looking over the literature of this interesting condition, to which Sampson has contributed so much important knowledge, Doctor Beer said that Rulle mentions 1300 cases collected in the literature. The endometriomata were found either in the musculature of the uterus, in the fallopian tubes, in the adjacent peritoneum, in the broad ligaments, in the round ligaments, in the ovaries, in the rectovaginal septum, in the vesicovaginal septum, in the navel, in inguinal hernia, in the omentum and other parts of the peritoneum, in the vagina, in the rectum, or in laparotomy incisions after Caesarian sections.

The causation apparently is not absolutely clear. According to Sampson, a piece of the mucous membrane of the uterus wanders through the tubes and in this way produces, by its growth, an endometrioma. On the other hand, others believe an embryonic rest or metaplastic cells explain the origin of these curious masses. Halban holds the view that the glands extend through the uterine musculature to the peritoneum and then through the lymphatics, and are spread in this way. Most writers seem to favor Sampson's interpretation.

Endometriomatous tumors situated in the rectovaginal septum have often been operated upon, and at times have been found irremovable. If the nature of the tumor can be proven, as in the case presented, castration, with or without radium implantation into the tumor mass through the vagina, may be the most satisfactory non-operative method of treatment.

## SPLENECTOMY FOR THROMBOCYTOPENIC PURPURA COMPLICATED BY MULTIPLE ENDOCRINE DISTURBANCES

Dr. Edwin Beer presented a woman, forty-eight years of age, who has always suffered from thyroid deficiency and has lived on thyroid extract. This condition seems to be familial, several members of the family being in the same condition. Past history of no significance.

In June, 1928, she began to bleed from various mucous membranes (gums and gastro-intestinal tract) with progressive anæmia. The anæmia was combated with repeated transfusions. Previous to the last transfusion, the hæmoglobin was down to 31 per cent. No toxic causes for the purpura could be found, and blood examination by Dr. N. Rosenthal showed typical changes of thrombocytopenic purpura.

When first seen by Doctor Beer, August 13, 1928, she was profoundly anæmic, with skin thickening, suggesting low-grade myxœdema; and the mucous membrane of the mouth and gums as well as the subcutaneous tissues of the skin of the body were discolored with small and larger hæmorrhages.

Abdominal examination negative. Spleen could not be felt definitely on account of the size of the patient. Although she had been taking about six grains of thyroid daily at different periods during six to seven years, there seemed to be no relation between this medication and the purpura. Bleeding began in June, 1928, but patient claims that she had been weak, feeling poorly for about six months prior to that.

Before operation, patient was given a transfusion of blood. August 14, 1928, a subcostal incision was made and a spleen of normal size was easily removed. As far as the wound was concerned, the patient made an uneventful recovery. She stood the operation very well and received another transfusion after the operation was over.

During the day following operation, her temperature was around 103°; she vomited, bringing up some blood clots, and bled a little from the gums. She looked sick and the extremities were icy cold and clammy. Urinary output was two ounces. Blood urea was 41.

In the second twenty-four hours after operation, blood examination showed an increase in hæmoglobin up to 53 per cent. Clot retraction was present and bleeding time had dropped from thirty minutes to three minutes. On this second day it was noted that her pulse was less regular and feebler. Vomiting had ceased and patient began to take fluids by mouth and held her rectal drip of glucose. The urinary output rose to six ounces and contained granular casts. Mental apathy profound; and hypoglycæmia 51.

On the third day patient gave signs of consolidation (broncho-pneumonia, pneumococcus type No. 2) in the left lower lobe. Temperature rose to 105.2°. Patient became stuporous with face twitchings; pulse though of good quality and force was accelerated to the rate of 120. Under further diuretics, oliguria gradually disappeared, but the patient's vasomotor disturbances in the extremities, as evidenced by the icy, clammy skin, persisted. The remarkable contrast between the satisfactory cardiac condition and the patient's stupor and the vasomotor depression, suggested some doubt as to a fatal termination. The patient was transfused again and a marked improvement developed during the next twenty-four hours.

On the fourth day after operation patient suddenly developed carpopedal spasms. By this time temperature had gradually come down; diuresis was satisfactory and the extremities were much warmer. Under calcium medication the carpopedal spasms disappeared, and with the disappearance of these the mental condition became much clearer though now, instead of being stuporous, the patient was irrational and excessively talkative.

About eight days after operation the symptoms of irrationality disappeared, and the mentality became clouded, patient very dull, and thickening of subcutaneous tissues more marked, suggesting an acute myxœdema. Under thyroid administration these symptoms cleared up, and by the eighth day after operation she continued to an uninterrupted recovery. Following operation there were a few small hæmorrhages from the gums and perhaps also from the stomach. Under the adhesive used for dressings, patient developed miliary petechiæ which rapidly disappeared. The patient has remained well since.

The pathological report on the spleen by Dr. P. Klemperer showed: "Hyperplasia of lymphoid cells in follicles and throughout the pulp with the appearance of extramedullary hematopoieses. The picture is suggestive of a leukæmic process."

## SARCOMA OF THE LIVER, EXCISION

Dr. Edwin Beer presented a man, thirty-eight years of age, who was admitted to Bellevue Hospital October 24, 1928, with the history that nineteen

years ago he had been operated upon in Massachusetts for what was probably a pyloric or duodenal ulcer with massive exudate about the ulcer simulating malignancy. At this time, judging from the present X-ray findings, a gastro-enterostomy had been done.

Following the above operation he had been well until about one and one-half years ago, when he began to have pain and signs of weakness in the right side of his body; also some pain in shoulder, hip and knee-joint. He thinks that occasionally he has been jaundiced, but has not lost any weight. During recent years he has had twenty-four salvarsan injections which possibly may account for some of the jaundice, which he thinks he noted.

His general health was not materially interfered with. He has had no urinary symptoms and no gastro-intestinal symptoms. His chief complaint on admission was pain across the lumbar spine, particularly in the right lumbar region.

Physical examination was completely negative except for a large mass in the right half of the abdomen which ballotted readily with the kidney. On deep inspiration the whole mass descended with the kidney and could not be held down as the diaphragm ascended. The edge of the liver could not be felt. There was no tenderness over the mass and no rigidity. The urine was negative.

An X-ray taken of the gastro-intestinal tract showed a normal gastro-enterostomy stoma, but the duodenum was not visualized. A van den Bergh test of his serum showed indirect positive, but direct was negative.

Under the impression that they might be dealing with a right kidney neoplasm, a pyelogram of the right kidney was made and the pelvis was found slightly dilated with normal calices. In this pyelogram the kidney outline was sharp, and the upper pole reached to the transverse oblique line represented by the lower edge of the liver (posterior lobe). This X-ray finding, showing the liver margin, suggested the diagnosis of a tumor arising from the capsule (either the fatty or true capsule) of the right kidney and reaching forward into the abdomen.

With this probability in mind, the patient was explored November 5, 1928, through a right lumbar incision which was extended forward so as to open the peritoneum widely. The kidney was exposed and found to be normal and in no wise involved. The peritoneum in front of the kidney was opened and on inspecting the inferior surface of the right lobe of the liver directly in front of the kidney, a tumor the size of an orange was seen which was whitish blue in color, covered with dilated veins. At first it simulated a gall-bladder, but the gall-bladder was found lying median to this tumor. The mass was tense, definitely cystic and projected about two inches above the adjacent liver surface. On drawing the elongated right lobe out of the wound, on the posterior lobe high up, a small subcortical area of discolorization was disclosed which suggested the appearance of a gumma, but probably was a secondary deposit similar to the large tumor. Unfortunately, aspirations of this mass sent to the laboratory proved to be of very little value for diagnostic purposes. Overlying the kidney on the peritoneal surface there were three or four flat, yellow plaques which were very suggestive of neoplastic deposits. Through this lateral incision, the partly cystic tumor was enucleated without encountering any severe bleeding until the lobe of the liver was entered. Where the liver was drawn out thin over the tumor there was scarcely any oozing, but where the mass was attached within the right lobe of the liver, there was rather copious venous oozing which could not be controlled with packing. In closing over this defect, chromic gut sutures of the Lembert type were used, folding under the edges of the liver which had been thinned out over the

tumor mass. By using this type of stitch, not only was the bleeding controlled satisfactorily but the large cavity in the right lobe of the liver was readily obliterated. Wound closed without drainage. The patient made an uneventful recovery.

The pathological report on the specimen was sarcoma, and the microscopic · report was spindle-celled sarcoma. (Doctor Symmers.)

Microscope shows presence of a new growth composed of rather short spindle-shaped connective-tissue cells and an abundance of smooth, pinkish staining intercellular substances.

In places these cells are arranged diffusely—in other places, they tend to arrange themselves in whorl-like formation. The nuclei are all of the mature variety and only moderately rich in chromatin. The mitotic figures are conspicuous by their absence. Scattered through the tumor at irregular intervals are noteworthy numbers of slit-like or cavernous spaces, some of which are occupied by red blood corpuscles.

If one may judge of the malignancy of this tumor by its histological characteristics, I should be inclined of the opinion that it is a spindle-cell sarcoma of no very extreme malignancy.

The patient was discharged from the hospital November 19, 1928, feeling perfectly well without our being able to locate any primary neoplasm.

On January 1, 1929, patient was re-admitted as he was complaining of some pain across his back. The only new symptom that he had developed was a melæna, which may be accidental and may be of some significance. Complete X-ray studies of colon, and all long bones, head and spine show no other focus. C. Garrk (1923) reports that probably twelve cases of sarcoma of the liver have been operated on. They are more frequent in childhood than carcinoma of the liver. Secondary sarcoma is sixty times as frequent as primary late secondary tumors. Liver may give symptoms thirty years after the primary disease has been eradicated.

## PYELOLITHOTOMY; PYELOPLASTY; REIMPLANTATION OF THE OBSTRUCTED URETER IN NEW KIDNEY PELVIS

DR. EDWIN BEER presented a man, thirty-eight years of age, who was admitted to Mount Sinai Hospital April 27, 1928, complaining of attacks of pain in the right kidney region for twenty-one months. More recently, during the last five months, he had similar attacks on the left side. All the more recent attacks were in the left kidney; they were very severe, associated with chills, temperature, vomiting, dysuria and hematuria.

X-ray examination showed large stones in the left kidney running into the calices; and smaller but less extensive calculi in the right kidney.

Cystoscopy showed good indigocarmine excretion on both sides; pus in both kidney specimens; urea on the right side 1.2 per cent., and on the left side 0.8 per cent.

In view of the fact that the chances of saving the left kidney by doing a conservative operation seemed problematic, it was decided to operate upon the right kidney in which the stones seemed to be placed more favorably for a conservative procedure. Having reëstablished fairly normal conditions in the right side, subsequently the left kidney could be dealt with as indicated by the pathological findings.

May 15, 1928, the right kidney was exposed and found hydronephrotic. The pelvis was as large as a peach and suddenly narrowed down at the ureteropelvic junction where it hung over a large accessory blood vessel crossing behind the ureteropelvic junction. The pelvis was opened posteriorly and eight fair-sized facetted stones were removed. X-ray control on the operating

table showed the kidney contained no more stones. Attempts to pass the ureteropelvic junction with a probe from above down, as well as through a small ureterotomy incision from below up, failed, probably owing to the traction on the kidney which displaced the normal relations, in part perhaps due to an ulceration which was found at the ureteropelvic junction on splitting the pelvis wide open. During these manipulations, the dilated pelvis, having been drawn through in front of the kidney where it could be more readily handled, the ureter tore at the ureteropelvic junction. The ureter, about one inch below the point of tearing, was healthy in appearance and was drawn up and attached through a stab-wound in the posterior surface of the pelvis. The ureter was attached with two stitches on the inside of the pelvis (plain catgut), and two stitches on the outside of chromic gut. To splint the anastomosis, a ureter catheter was led down through the small ureterotomy incision which had been made to probe upward through the ureteropelvic junction at the beginning of the operation. This catheter was then led through the posterior pelvic wall alongside the reimplanted ureter running parallel to it and out through a small incision in the anterior pelvic wall. The pelvis was sutured by infolding so as to make a small pelvis, funnel-shaped, with the ureter coming out at its dependent part.

About six days after this operation, the splint catheter was removed and the wound healed rapidly.

June 24, 1928, the patient was cystoscoped to determine the function of the reimplanted ureter, and it was found that the catheter ascended twenty-four centimetres on this side and that the indigocarmine output was fair. On the left side the catheter ascended further and the indigocarmine was strong. Also the calibre of the stream on the right side was smaller than on the left. Urea concentration on the right side was .1 per cent. and on the left .6 per cent. On the right side there were a few pus cells, and on the left a few granular casts.

The man was discharged from the hospital June 5, 1928, with instructions to report subsequently for treatment of the stone in his left kidney.

Four days after discharge he had a severe colic on left side with a temperature of 104°.

On re-admission he was cystoscoped and the right catheter ascended twenty-four centimetres, and coming from this side the urine was brilliant and clear and contained strong indigocarmine; microscopic examination showed a few pus cells and urea was 2.3 per cent. The left side showed an obstruction at twenty-four centimetres, and thick pus was washed out from the ureter at this level and then the catheter passed thirty-five centimetres; there was no secretion obtained through the catheter so the catheter was left *in situ* and the diagnosis of obstructed, infected, calculous pyonephrosis was made.

The patient apparently was definitely living on the previously operated right kidney.

With the indwelling catheter in the left kidney, secretion gradually came back, so that nine days after introduction of the indwelling catheter, phthalein output from the left kidney in four hours was 10 per cent., three ounces of urine being obtained; during the same time patient voided sixteen ounces of urine containing 35 per cent. phthalein.

DR. ABRAHAM HYMAN, to how important it is to be conservative in stone surgery, and to make every possible attempt to save the kidney, related the following case-history:

A young girl was brought to the hospital with a large stone in the right

kidney. An X-ray examination showed no calculi in the opposite kidney. Cystoscopy demonstrated markedly impaired function on the side of the stone; the other kidney was normal. Following pyelotomy, a sinus persisted in the lumbar region, through which all her urine was discharged. A post-operative cystoscopic examination demonstrated an obstruction at the ureteropelvic junction which could not be passed, and no urine was obtained from this kidney. A pyelogram verified this obstruction at the ureteropelvic junction.

After waiting at least six weeks, during which time all the urine from the right kidney discharged through the sinus, a secondary operation was decided upon. At this operation it was found that the upper end of the ureter had apparently sloughed away, and was sealed off. The kidney was embedded in a mass of dense, fibrous tissue. It was considered impractical to do a ureteropelvic anastomosis, and the kidney was accordingly removed. The patient returned about eight months after this second operation, during which time she had developed a large calculous in the left kidney. Her condition was rapidly growing worse. The blood chemistry mounted steadily, and before operative interference could be undertaken she died of uræmia.

## LATERAL ANASTOMOSIS BETWEEN THE BRACHIAL ARTERY AND VEIN TO REDUCE BLOOD PRESSURE IN A PERFORATING ANEURYSM OF THE AORTA

DR. EDWIN BEER presented a specimen of lateral anastomosis between the brachial artery and vein, saying that some years ago Dr. Eli Moschowitz had suggested to him the possibility of controlling the high blood pressure in primary hypertension cases by making an arteriovenous aneurysm. According to the literature of arteriovenous aneurysm, the general blood pressure drops as a result of this abnormal communication; in turn the heart hypertrophies and eventually gives out. If patients with primary hypertension could have their lives prolonged by producing arteriovenous aneurysm, it might be a useful procedure. In thinking the matter over, in view of the disability produced by an arteriovenous aneurysm, he decided that the only feasible non-crippling site for such an anastomosis in a right-handed patient would be in the left brachial artery and vein.

At this time a man, fifty-two years of age, was admitted to Mount Sinai Hospital April 10, 1928, to the Medical Service of Dr. George Baehr, complaining of terrific pain over his left chest anteriorly where for two months a growing, pulsating mass was developing. Twenty years ago, patient had had a syphilitic infection for which he received treatment, but the Wassermann was still four plus.

Physical examination showed the mass in the left anterior aspect to be a large aortic, arch aneurysm which had eroded the ribs and part of the sternum and which projected beyond the level of the adjacent skin about five to six centimetres and was about ten centimetres in diameter.

The medical attendant suggested an anastomosis between the right common carotid and the right jugular vein, as had been carried out successfully by Wayne Babcock. After reading the report of this case, not being entirely convinced by the physiological discussion and the fear lest such a sudden upset in the circulation might be fatal, placing an undue strain on the

right heart and pulmonary circuit, Doctor Beer determined to make use of what he had previously decided to try in a primary hypertension case, and carried out, under local anæsthesia, a lateral anastomosis between the left brachial artery and vein, making a stoma in the typical way about three-fourths inch in length.

Pre-operatively, the blood pressures were as follows: 140/80; 135/75; 140/90; 145/95. Immediately following operation, radial pulse was present and the diastolic pressure had dropped to 30. Pain in the chest within twenty-four hours was gone and the thumping sensation subsequently disappeared. The circulation in the left hand had not changed.

Repeated blood pressures after operations gave the following rating: 115/55; 106/58; 116/60; 104/50; 116/60; 118/62; 110/68. All these were taken within two weeks of the operation. Patient was out of bed during the second week. On auscultation of the site of the arterovenous aneurysm, there was a distinct bruit. The patient stated that he felt ever so much better, the subjective sensations of beating in the aneurysm having disappeared and his pain, which had been severe, had also definitely disappeared.

About three weeks after the operation, the arm suddenly began to swell down to the wrist, apparently due to either a phlebitis or a lymphangitis which disappeared after wet dressings.

Further blood pressures were as follows: 110/58; 125/60; 114/68. A comparison of these eleven blood pressures (post-operative), with the four pre-operative blood pressures shows a well-marked drop in both systolic and diastolic pressures, which was the object of the surgical procedure.

The patient was allowed to go home June 1, 1928, the operation having been done April 22, 1928. He was advised against doing anything rash.

He was out of the hospital ten days when he returned with multiple ulcerations of the skin over the aneurysm, which ruptured in the ward two days after admission with immediate fatality.

Before the aneurysm ruptured the blood pressures showed: 126/72; 118/68. The post-mortem examination showed luetic aortitis with perforation of aortic aneurysm. The anastomosis between the brachial vein and artery was patent and no evidence of any thrombosis. The intima at the site of anastomosis was slightly thickened. In addition to the main aneurysm in the aorta nearby there was a second aneurysmal dilatation.

## SOME CLINICAL FINDINGS IN SUBTOTAL GASTRECTOMY

DR. CONSTANTINE J. MACGUIRE, JR., read a paper with the above title for which see page 658.

DR. HERMAN FISCHER felt that Doctor MacGuire did the proper and right thing in doing a partial gastrectomy in the case of a small gastric ulcer, especially because the patient was suffering in addition from a severe chronic gastritis. Some European surgeons have even gone so far as to advise resection of stomachs in patients who have been suffering from chronic gastritis and who could not be cured by medical means. Doctor Fischer considered this teaching very dangerous and going too far, but there was no doubt in his mind that it is not the *size* of the ulcer which should influence us in our decision for resection. After a good many disappointments with the results of gastro-enterostomies in gastric and duodenal ulcers he began to do a subtotal gastrectomy in all cases in which it was feasible. He thinks to call some

surgeons who do more resections than gastro-enterostomies "radicals" is a misnomer. Every surgeon who has had a large experience in stomach work will be radical when it is indicated and will be conservative when he knows that by radicalism he will do more harm than good. As to the question of duodenal ulcers, Doctor Fischer resects in some cases and in some he doesn't. In fact he said he never knew before the opening of the abdomen what he was going to do, and feels it is a bad plan to tie oneself down to any specific operative procedure before a thorough inspection of the existing pathological condition has been done. The late results after resection, as seen in our follow-up clinic, four or five years after operation, are much more gratifying than the late results after gastro-enterostomy. Almost invariably the resected patients have no complaints at all, they need not keep a special diet and they have forgotten entirely that they ever had a poor stomach.

If you interrogate the patients with gastro-enterostomies a large percentage of them will complain of more or less stomach distress and some will tell you that they are not benefited at all by the operation. Doctor Fischer's mortality rate is 8 per cent., or was several years ago. Doctor Fischer felt he had overlooked ulcers and is never satisfied with his examination unless he has opened the stomach. He opens the stomach, examines it and palpates the mucous membrane of the duodenum. He has used the cystoscope or, what is even better, the sigmoidoscope for direct ocular inspection of the duodenum, and in spite of this careful ocular and digital examination he has in one case overlooked the ulcer. Several months later the patient was operated upon by Doctor St. John and cured by resection. Sleeve resection for ulcer at the lesser curvature should not be done, Doctor Fischer thought, because in his opinion it is often followed by an hour-glass stomach. He had had no experience with ulcer excision and felt that resection is a better operation. The patients get well after resection in spite of their ulcer constitution, so-called. This constitution one cannot change and will have to put up with. It is better to have the ulcer out than have it perforated, or have it degenerate into carcinoma. Doctor Fischer has shown several cases here in which a jejunal ulcer had developed, among them were three of his own cases in which he was forced to do a gastro-enterostomy and he doesn't know how large a percentage of jejunal ulcers we have in our American hospitals. He therefore prefers subtotal resection in every case where the general condition of the patient will allow it.

DR. JOHN A. McCREERY said that he had seen most of the cases operated on by Doctor MacGuire and had been impressed by their smooth post-operative course, in spite of the difficulties of the procedure in the secondary cases. The comparatively large number of the latter had led him to review the cases of duodenal ulcer on the First Surgical Division of Bellevue Hospital with the feeling that it might be possible to select certain types in which a primary resection was justifiable.

Somewhat to his surprise Doctor McCreery found that primary resection was being done in about 10 per cent. of these cases, usually in cases where hæmorrhage made destruction of the ulcer advisable, while the large size or position of the ulcer made this impossible by less extensive procedures. In the ordinary case, however, he felt that gastro-enterostomy or pyloroplasty with its 70 per cent. of satisfactory results, as shown by a careful follow-up, was still the advisable procedure.

His personal preference was for the posterior polya operation although he realized the advantages of the Balfour modification if further operation should be necessary. Provided the removal of the lesser curvature was adequate, the type of procedure made little difference.

Dr. Fordyce B. St. John said that the follow-up studies at the Presbyterian Hospital during the past twelve years have demonstrated the reasons for coming to the same conclusions to which Doctor MacGuire has come; viz., that partial gastrectomy seems to be the operation of choice in recurrent and marginal ulcers.

Dr. Henry W. Louria (by invitation) said that from October, 1927, to February, 1928, he had the privilege of serving as a voluntary assistant on the gastric service of von Haberer at the University of Graz.

Von Haberer, who is a pupil of the school founded by Billroth and continued by von Eiselsberg, has been interested in the question of ulcer for the past twenty years. Dissatisfaction with the results of gastro-enterostomy in the treatment of ulcer, led him to try other procedures such as the sleeve resection of Riedel and Payr and pyloric occlusion as advocated by von Eiselsberg. The latter procedure was followed by an unusually high percentage of marginal ulcers.

For the past fifteen years von Haberer has been employing subtotal gastric resection almost exclusively for the treatment of ulcer, whether gastric or duodenal. He emphasizes the importance of resecting the lesser curvature of the stomach and the distal portion of the greater curvature, commencing at the point where the left gastro-epiploic artery pursues its course from left to right along the greater curvature. The amount of stomach removed depends upon the size of the stomach; but in every instance includes the entire lesser curvature.

One of the drawbacks of gastric surgery abroad is the absence of a systematic follow-up, as we understand it in this country. The patients are not routinely instructed to return to the clinic at specified dates, although the staff claim that they have a fairly good impression of their results. During his stay at Graz the speaker sent a follow-up letter to all patients who were operated on from January 1, 1925, to December 31, 1926. This series included 257 patients, of whom only 179 could be traced. Forty per cent. of the patients were examined in the clinic and the rest responded by letter. Eighty-five per cent. of the patients were completely symptom free. Ten per cent. complained of occasional gastric upset following overeating or the ingestion

of sweet foods, 5 per cent. were either unimproved or worse than before the operation. The total mortality following resection in this group of cases was 8.4 per cent.

The operation which von Haberer prefers is the Billroth No. 1 when technically feasible. The second choice is the terminal lateral modification of the Billroth No. 1, and his last choice the Billroth No. 2. Throughout Germany, Austria, Switzerland and Hungary, in the leading university clinics, extensive gastric resection was the method of-choice for the treatment of gastric or duodenal ulcer. There are but few hospitals that still prefer gastro-enterostomy for the surgical treatment of gastroduodenal ulcer.

DR. EDWIN BEER called attention to the fact that the proper treatment of duodenal and gastric ulcers, especially the surgical treatment, is in a state of flux. The literature is so full of contradictory statements concerning the incidences of secondary ulcerations and the advisability of doing extensive gastric resections that the surgeon is liable to be in doubt as to just what he should do in any particular case.

Fischer and Lewisohn have mentioned the fact that gastrectomy (subtotal) is preferable to gastrojejunostomy which leads to secondary gastrojejunal ulcerations in a large proportion of patients (up to 33 per cent.) Other surgeons report an incidence of between 2 and 4 per cent. of these secondary ulcerations in duodenal ulcers.

It would seem that this contradiction might be straightened out by the pathologists who must be seeing numerous cases of duodenal ulcers in which a gastro-enterostomy has been done, and they could in some of the large pathological laboratories, as well as in the Societies of Pathology, gather together a suitable number of patients and thus establish the correct incidences of secondary gastrojejunal ulcerations following gastro-enterostomies for duodenal ulcers. Whether the variations in the technic of gastrojejunostomies lead to varying incidences of secondary ulceration, it is difficult to say. In Balfour's recent analysis of one hundred physicians on whom gastrojejunostomies have been performed for duodenal ulcers, the incidence of secondary ulceration surely was what is generally considered by most surgeons as the normal incidence of this complication—between 2 and 4 per cent.

He personally had operated upon some 150 duodenal and gastric ulcers—most of them duodenal—and though at the present he favors in duodenal ulcers the Finney pyloroplasty with excision of the ulcer, still in a large number of cases, he has done nothing but the no-loop right-to-left posterior retrocolic gastrojejunostomy, and, as far as I know, only one of these cases has developed a demonstrable secondary jejunal ulcer. The end-results reported by Finney and his colleagues on the pyloroplastic operation—which goes by his name—also compare very favorably with the above publication by Balfour, and it would seem that gastrectomy for duodenal ulcer is as yet too radical a procedure and not justified.

Another interesting contradiction that one encounters in the literature is

found in the fact that one group of "resectionists" claims that one must take away most of the stomach and produce an anacid condition to prevent secondary ulcers. Another group reports secondary ulcers in the face of anacidity.

Von Haberer, who does a Billroth No. 1 operation, naturally cannot remove as much of the stomach as those who do a Billroth No. 2; still, von Haberer is satisfied with his operative procedure and claims that recurrences do not develop. Furthermore, even subtotal gastric resections, which deprive the patient of so much stomach that he empties at once into his jejunum and is not aware that he has a stomach, does not apparently prevent secondary ulcerations.

As already mentioned, numerous cases of secondary ulcerations have been reported following subtotal gastrectomy, and Nystroem has collected from the literature sixty-one such cases to which Balfour has added some eighteen more. This is in contrast to the recognition of secondary ulcerations following gastro-enterostomies. Following gastro-enterostomies, one of the earliest reports of secondary jejunal ulcerations was made by M. von Cachovic, in 1904, who reported three cases of his own and collected nine more from the literature. This covered a period of about twenty years following the introduction of gastro-enterostomies. In the short period in which subtotal gastrectomies have been done, it is surprising that seventy-nine cases of secondary ulcerations have been reported even after making due allowance for the improved methods of diagnoses of this complication at the present time. Whether the "radical" surgeons are going to become less radical in the future remains to be seen. The possibility of these secondary ulcerations following subtotal gastrectomies has already led to advising an anticolic gastro-enterostomy so as to be more readily able to deal with secondary ulcerations (Ranzi). Furthermore, to relieve subtotal gastrectomy of any blame for the later gastro-jejunal ulcers, Spaeth has attributed these to ulcerations in misplaced islands of gastric mucosa.

The attitude of the speaker can be summed up as follows: In duodenal ulcers, wherever possible, excision of the ulcer with pyloroplasty, a wide duodeno-gastrostomy being made. Whenever impossible, a no-loop Mayo posterior right-to-left gastrojejunostomy with light clamps and using absorbable chromic catgut throughout. On the other hand, in ulcers of the stomach resection whenever possible, the Hofmeister technic being used. In those cases where resection cannot be performed, a no-loop gastrojejunostomy, or simple jejunostomy, should be done for the relief of pain and feeding purposes.

DR. RICHARD LEWISOHN stated that recurrences following resections of the stomach were often caused by incomplete operations. It is a well-known fact that pylorectomies do not reduce the gastric hyperacidity and are sometimes followed by recurrences. The term subtotal gastrectomy should, as the name implies, be reserved for cases in which the upper line of dissection is situated very near the cardia. Among the pictures shown by Doctor MacGuire two cases deserved this classification. The others were at best partial gastrectomies.

He agreed with Doctor Fischer that some ulcers cannot be removed without grave risk to the patient. About 95 per cent., however, or gastroduodenal ulcers can be resected without great technical difficulties. The speaker has used partial or subtotal gastrectomy as the method of choice during the last six years with a mortality of 5.5 per cent.

STATED MEETING HELD JANUARY 23, 1929

The President, DR. FRANK S. MATHEWS, in the Chair

## TUBERCULOSIS OF DEEP TROCHANTERIC BURSA

DR. WALTER M. BRICKNER presented a lad, now nineteen years of age, who a year ago entered the Hospital for Joint Diseases with the diagnosis of chronic osteomyelitis of the great trochanter of the left femur. This diagnosis was based on pain referred especially to that area, localized tenderness, and the X-ray appearance. There was no fever above 99.5°. Flexion, extension and external rotation of the left hip were limited, but apparently only by pain. The gait was correspondingly awkward. No swelling was noted on or in the neighborhood of the trochanter; but over its centre was a circumscribed area of what appeared to be bone tenderness. Röntgenograms of the hip showed only roughening and erosion of the cortex of the great trochanter. The pain was fairly continuous and severe.



Fig 5.—Tuberculosis of the deep trochanteric bursa. Specimen partly filled with wax.

The patient's history, as later pieced together, dated back to the summer of 1924 when, a year or more after a fall on his left hip, he developed pain there. During the next three years he was for various periods in several hospitals in New York and vicinity.

At operation an incision was made from about seven centimetres below the crest of the ileum downward on the lateral surface of the buttock about twenty-five centimetres. The fascia over the trochanter was split, entering the deep trochanteric bursa, from which there escaped much thin, yellowish fluid. A fibrinous mass the size of a hen's egg was exposed and removed from the bursa. This bursa proved to be enormously enlarged, thickened and multilocular, extending upward and backward under and between the glutei, and downward under the thigh muscles, to all of which structures it was closely adherent. Without dividing any muscle bundles, and by dint of retracting and patient dissection, the entire complicated sac was enucleated *en bloc*, after emptying it of its fluid and fibrinous masses. It contained no rice bodies. A rubber dam drain was inserted and the fascia and skin were closed. The operation occupied two hours, and was followed by mild shock.

There was profuse serous discharge for several days; and on the sixteenth day about an ounce of pus escaped from the centre of the wound. The patient left the hospital February 23, 1928, three weeks after the operation, without pain and walking well. The skin had healed with three sinuses which continued to discharge serum while the boy was again an out-patient. To effect closure of these he was sent on April 11, 1928, to the Country Home of the hospital, at Far Rockaway, Long Island, where he was treated with high caloric diet and heliotherapy, natural and artificial. When discharged from the County Home, in June, he had gained four pounds and his wound was healed. The scar has given no further trouble and the patient has continued to feel well.

Following is the report of Doctor Jaffe, the hospital pathologist: "The *gross specimen* (Fig. 5) is a very large bursa, measuring at least fourteen centimetres in length. It consists of one large cavity and one smaller cavity that communicates with the larger one, and measures about four centimetres in length. Across, the bursa is about twelve centimetres in largest diameter. It measures up to about three millimetres in thickness. The bursa contains a whitish, coagulated fibrinous material. The wall is somewhat granular. *Microscopical section* of the material that filled the bursa shows an acellular fibrinous mass. Several sections from the bursal wall show it to be lined by a tuberculous granulation tissue. Scattered through the wall is an occasional well-formed tubercle with giant cells. *Culture* of the fluid removed at operation is sterile, and smears show no bacteria. *Diagnosis.*—Tuberculous bursitis."

Doctor Brickner said he had seen only two other instances of tuberculosis of a trochanteric bursa, many years ago. Both of these bursæ were small and easily removed.

## MYCOTIC ULCERS OF THE LEG AND PYARTHROSIS OF THE KNEE

Dr. Walter M. Brickner presented a woman, thirty-six years of age, who was admitted to his service at the Hospital for Joint Diseases October 1, 1927, for the treatment of acute pyarthrosis of the left knee. She was about two and one-half months pregnant, had borne two children, and had been operated on for a right ureter calculus. Nine days before admission she felt pain in the left knee and noticed a "boil" on the middle of the anterior aspect of the left leg. This grew larger and at the same time the knee became swollen and more painful. Two "boils" soon appeared just below the first one, one on each side of the leg.

On admission there was noted a circumscribed cutaneous infection over the midshin, somewhat furuncular in type, and what looked like a discharging furuncle on each side of the leg, just below this lesion. The left knee was distended with fluid, hot, painful (especially on attempted flexion) and tender on its lateral aspect where the skin was slightly reddened. The temperature was 103°, the pulse 120. The urine was free of sugar (and remained so throughout). The initial blood count showed 10,100 leucocytes; 70 per cent. neutrophiles; 26 per cent. small lymphocytes; 4 per cent. large lymphocytes.

Doctor Brickner said he obviously had to deal with a pyarthrosis, but subacute rather than fulminating. He emptied the joint immediately, by needle puncture, evacuating fifty cubic centimetres of thin, cloudy, yellowish fluid. Five-pound traction was attached to the leg to separate the joint surfaces; and a wet dressing was applied to the skin lesions. The fluid from the joint contained pus cells in abundance, but no bacteria were seen in it, and cultures remained sterile.

The next morning the joint, having become again distended, was emptied a second time and, between two needles, was washed out thoroughly with 1000
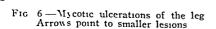
cubic centimetres of Dakin's solution. There was no refilling after this lavage of the knee. In the thin purulent fluid removed on this occasion no bacteria were found, and cultures remained sterile. Blood cultures also showed no growth. The next day the patient could flex and extend her knee without pain. There were, however, an area of discoloration near the joint on the medial aspect of the thigh, and pronounced swelling from just below the knee to the groin. The temperature was 102°; there was no crepitation or redness. This swelling disappeared gradually in about two weeks, by which time the patient could flex her knee 90° without effort. After the seventh day the temperature was never above 100°.

By the tenth day the lesion on the front of the leg had grown much larger. It is now a circular red ulcer, with small scattered areas of deeper suppuration. The smaller lesions below it look similar. The larger lesion at that time was of the size and appearance shown in the photograph (Fig. 6), on which the arrows indicate the smaller lesions on each side. Each of these ulcerations had a reddened base, and irregular edges, somewhat undermined, with only slight surrounding inflammation. On smears then made from the droplets of pus that could be expressed Doctor Blair, the hospital bacteriologist, reported: "Relatively large number of pus cells. No bacteria seen. A fungus is present, identity not established"; and from a culture on Sabouraud's medium: "Organism belongs to group of higher bacteria probably related to streptothrix." No growth was obtained in other media. The same mycelial organism was recoverable again and again from the leg, but no further identification was made.

Doctor Gross, of the dermatological staff, recorded: "A clinical diagnosis is not possible. For sporotrichosis there is not enough gummatous appearance. Blastomycosis is more probable. The cutis seems to be primarily involved." He failed to secure a growth of the organism on Sabouraud's medium.

On October 18 it was noted that the skin had broken down at the side of needle puncture on the medial aspect of the knee. Here a slough formed, extending down to, but not into, the joint. In pus that discharged from this sloughing channel there were repeatedly found mycelial organisms



Fig 6 —Mycotic ulcerations of the leg
Arrows point to smaller lesions

of the same appearance as from the leg, and no other bacteria. In about a month, under treatment by acriflavine and other antiseptic solutions, the sloughing and suppuration ceased and definitive healing took place at that site, with no effect upon the knee function.

Many remedies were tried for the lesions on the leg; iodine (locally, intravenously and, for a long period, by mouth), acriflavine, gentian violet, thymol, potassium permanganate, yeast, boracic acid powder (to overcome a pyocyaneus contamination), and ultraviolet light. The most satisfactory progress was made while the areas were dressed with a solution of acriflavine neutral, 1:4000, removed daily for exposure to ultraviolet rays. Doctor Brickner would hesitate, however, to attribute any specific influence to either of these measures.

By November 13 both of the smaller areas on the leg were healed, and the larger one was contracting slowly by peripheral epithelization. By November 30 it was reduced to 50 per cent. of its maximum size and was granulating. Nevertheless, it continued to yield the mycotic organism on smear.

When the woman was transferred to the out-patient department December 31 the ulcer was rather less than two centimetres in diameter. Under treatment by ultraviolet light and mild antiseptic dressings healing was complete by March, 1928—a total period of five months. A small ulceration reappeared in the scar after a few weeks, but gradually healed; and there has been no recurrence for many months. The knee function is excellent. For completeness of record it may be added that the patient gave birth to a normal child at term, that her blood Wassermann reaction was negative, that several of her teeth were in unsatisfactory condition, and that röntgenograms of the knee, after the lavage, showed only slight marginal lipping.

The surgical interest in this case is not so much in the mycosis of the leg, unusual though it was, as in the coincident suppuration in the joint just above. Since no bacteria were found in the pus from within the knee, and since morphologically the same organism as found in the leg lesions were also found, uncontaminated, in the pus that formed along one of the needle tracks, it seems not unreasonable to believe that the pyarthrosis was also mycotic. Very likely the mycelia were present in the smears made from the joint pus and were not recognized as such.

## SO-CALLED TRAUMATIC SYNOVITIS OF THE KNEE

. Dr. Walter M. Brickner, in presenting this case, said the aspiration treatment of so-called traumatic synovitis of the knee is not new. It was employed by Willems twenty years ago and by others before him; and, among members of this Society, it has been recommended by Moorhead, McWilliams, Whitman, and the speaker. Nevertheless, its beneficence and routine usefulness have not found the recognition that the method deserves, either in practice or in text-book teachings.

For many years Doctor Brickner has been routinely aspirating acute traumatic effusions, not only in the knee—which especially lends itself to the method—but also in other joints, even of the fingers. It has been his experience—and Metcalf and Harding had each made the same observations—that in the early stage of an acute traumatic "synovitis" the fluid in the joint is blood or bloody, and the condition is thus, in fact, usually one of hemarthrosis. Only as the blood is absorbed in the course of several days does it become one of "water on the knee". In his article on the aspiration treatment (*American Journal of Surgery*, February, 1925) Doctor Brickner said, referring to the knee: ". . . it reduces the period of disability from many weeks to a few days, and the period of treatment from two months or more to two weeks or less!", and, ". . . we must alter our conception of the pathology of

joint sprains. As concerns the knee certainly, and all other joints quite probably, there is in a 'sprain' a tear of the synovial membrane, associated with some injury (break or tear) in ligament, cartilage or bone. An infraction (crack) in the patella, femoral condyles or articular end of the tibia probably occurs more often in knee sprains than is recognized." . . .

To illustrate these postulates concerning both therapy and a not-infrequent etiology, he presented a man, twenty years of age, who, on October 11, 1928. was thrown down by a passing automobile, suffering an injury to his right knee, which promptly became swollen, and an abrasion of the right leg. He was at once removed to a municipal hospital. Therefrom after six days he was brought by his family to the Hospital for Joint Diseases. With him came the official report from the first hospital that the patient "was hospitalized at this institution from October 11 to October 17, 1928, during which time he was treated for traumatic synovitis of the right knee and abrasion of the right leg. X-ray findings reveal 'evidence of synovitis with fluid'."

When admitted to the Hospital for Joint Diseases the right knee was distended with fluid and very painful, especially on attempted motion. Sixty cubic centimetres of blood were withdrawn by needle, which gave prompt relief of pain. A gauze roller was snugly applied, allowing a ·slight range of motion only ; and the patient was kept in bed. Röntgenography, after the joint was thus emptied, clearly showed a marginal fracture of the lateral condyle of the tibia, with separation of a shell-like fragment of bone.

Two days after the first aspiration the joint had become again distended and painful. Forty cubic centimetres of blood were withdrawn and the joint was immobilized on a posterior splint.

Three days later the joint, again distended, was relieved, by aspiration, of fifty cubic centimetres of blood fluid. There was a further slight reaccumulation of fluid during succeeding days, but it gradually disappeared.

November 3 the patient was allowed to walk with crutches, bearing no weight on the injured side. November 6, an X-ray film showing the fragment of bone reattached, weight-bearing was begun cautiously and gradually increased in time allowance. November 9 (about thirty days after the injury), there being no recurrence of fluid or of pain, the patient was discharged. He could then extend his knee fully and flex it 90° ; and the knee was of normal appearance. He has regained full function and has very little discomfort.

A crack in one of the bones entering into a joint may easily escape demonstration by röntgenography, unless exposures are made in several directions and with pains to secure osteal detail. A separation, more or less complete, of a fragment of the articular cartilage over a femoral condyle will not show in röntgenograms unless a bit of bone is torn off with it. Such a cartilage tear is also a cause of "traumatic synovitis of the knee", and of "water on the knee" ; and when, after an injury, there is recurrent effusion it is one of the possible causes that deserves prominent consideration.

Dr. John J. Moorhead thought immediate aspiration was the best method for shortening disability. He agreed that the fluid was rarely serous. He had found practically pure blood in a joint as late as six weeks after the onset of a traumatic synovitis.

Another important point was the flake fractures mentioned by Doctor Brickner and these and other intrinsic sources of joint irritation are often more causative than extrinsic factors in the production of synovitis. The situation is not unlike that which occurs in fracture of the patella. The patient falls and believes that contact with the ground broke the knee cap, although

the fact is that a contraction of the knee caused the fracture and that it preceded contact with the ground. Many of these cases of traumatic synovitis are due to what might be called joint calculi, and in so-called recurrent synovitis one should always suspect some source of intrinsic trouble.

In closing the discussion, Doctor Brickner added that routine aspiration is the ideal treatment of "traumatic synovitis" whether the underlying lesion is fracture or merely a "sprain". These cases do much better, he thought, when aspirated at once. In mild cases only one aspiration may be necessary, or possibly two, especially if immediate weight-bearing is not permitted which is apt to cause fresh bleeding. This case was shown, first, to emphasize that what has been called traumatic synovitis is not a simple serous effusion. He recommended aspiration not merely because there is blood there, for he does the same thing when he knows the fluid is no longer bloody. The blood gradually disappears, and even after it has grossly disappeared one still finds red-blood cells and bile pigment in the fluid. Second, in a very large proportion of these cases of "traumatic synovitis" the underlying lesion is a more serious injury than is suspected by simple examination. X-ray pictures taken in several directions and with great care to get bone detail will often show a fracture; and in cases where fracture is not shown there may be tearing off of a piece of articular cartilage which does not show in the röntgenogram unless a layer of bone is attached to it.

## FRACTURE OF NECK OF FEMUR, OUTER THIRD

Dr. Seth M. Milliken presented a man, sixty-five years of age, who sustained a fracture of the neck of the femur, outer third, October 28, 1926, by being run down. He was admitted to the hospital and immediately put in traction and suspension with the thigh in moderate abduction.

X-ray the succeeding day showed about one inch upward displacement of the outer fragment. Several manipulations were attempted without correcting the deformity, then bone tongs were applied just above the condyles of the femur and twenty-five pounds applied to the cord. This giving over-correction of the deformity, the weight was reduced to seventeen pounds, which held the fragments in almost perfect apposition. This was maintained for two weeks and the weight then reduced to twelve pounds. The tongs were left in twenty-eight days. The leg was suspended in traction in a Thomas splint with Pierson leg piece, with the knee moving throughout the treatment.

November 28, 1926, one month after injury, measurement showed the two thighs symmetrical. There was voluntary motion in hip-joint.

The patient was kept in bed three months and then allowed to be up on crutches and encouraged to use the extremity without weight-bearing.

At the end of five months the patient was using leg normally, though was still using crutches when on the street. Since then he has been walking without support. X-ray fourteen months after injury showed complete bony union with slight increase in the angle at the junction of neck and shaft, that is, reverse coxa vara.

This method is recommended as containing all the elements of Whitman's abduction treatment, with the additional advantage of maintaining the tone of the adjacent muscles, diminishing the amount of atrophy, thereby increasing the nutrition of the part and hastening the bone regeneration.

## FRACTURE OF THE CARPAL SCAPHOID WITH FRACTURE OF THE NECK OF THE RADIUS

Dr. John M. Hanford presented a man, forty-six years of age, who, on January 12, 1925, walked into an open elevator shaft falling one story to the bottom of the shaft. He received numerous contusions, but mainly suffered in his right elbow, forearm and wrist. There was no deformity of the right upper limb but pain and tenderness pretty well localized to the upper extremity of the radius, increasing on rotation and to the outer aspect of the carpus with the special tenderness in the anatomical depression located in the posterolateral aspect of the carpal region.

Radiographs made six days later showed a linear lateral vertical fracture through the scaphoid with no displacement, and a transverse fracture through the neck of the radius just below the head, with some impaction anteriorly. The treatment consisted of a splint to immobilize the scaphoid for eight weeks from the day of fracture, continuously, with active rotation of the forearm after about two weeks.

Two weeks from the injury, during which time the splint had been worn, after consultation, the splint was discontinued. For it was substituted a webbed bandage around his wrist; hot soaks locally; and light active motion on all joints was begun. The avoidance of adhesions to the orbicular ligament at the upper end of the radius was deemed especially important.

Sixteen days after the injury, the patient played the piano, with much pain at both wrist and elbow. By the eighteenth day pain was decreasing and motion increasing. On the twenty-first day he resumed regular work—playing the piano daily. He wore the bandage only until the twenty-eighth day. At the end of eight weeks he had recovered full function; had no pain; and appeared cured. He has had no subsequent trouble.

## FRACTURE OF THE CARPAL SCAPHOID

Doctor Hanford presented a second patient in the person of a woman, thirty-five years of age, who tripped on ascending steps December 14, 1928. She fell forward on the base of each palm. At first she had no pain, but within an hour or so noticed moderate pain and numbness in the left wrist and up and down the whole forearm, wrist and hand. Pain increased on motion of the wrist and forearm and increased during the following few days. Her grip was weak, and all heavy lifting was painful. She was seen by the reporter two days after the injury when her symptoms had not reached their maximum and when the signs were so vague that he did not think she had a fracture. He advised a sling, rest, and hot soaks.

Ten days after the injury she was having increased pain. Radiographs were then made of both wrists with the result that a barely perceptible fine linear fracture was seen to run vertically through the scaphoid, transverse to its long axis, with no displacement.

Twelve days after the injury, anterior and posterior moulded plaster splints were applied immobilizing the wrist, carpus, metacarpals and proximal phalanges. Even with these, she continued to have pain and the plan of removal at home for hot soaks and massage resulted in discomfort from inaccurate replacement of the splints.

She was then confined to bed with a mild attack of "flu" for a few days, but even during this quiet period continued to have pain.

January 12, twenty-nine days after the injury, a circular plaster bandage was applied. This has been much more comfortable but even so has not given complete relief from pain.

## DISLOCATION OF CARPUS

DOCTOR HANFORD presented a third patient, a man, forty-five years of age, who, on October 13, 1928, was thrown from a horse and injured his right wrist on which there was a small wound which did not bleed. He very soon had a great deal of pain in the wrist and was unable to extend the fingers, in which he felt numbness. Splints were applied by a local doctor. He was first seen by me that same evening. On removing the splints and dressing, the fingers and hand were swollen. The hand was soiled. There was thickening of the wrist from before backward; also a five centimetre transverse, slightly gaping wound on the ulnar side of the front of the wrist. The carpus appeared to be displaced radially. There was a sense of a bony prominence in front of the wrist; though not the typical deformity of a Colles's fracture; and partial anæsthesia corresponding to the median nerve in the fingers. The fingers were flexed at the metacarpo-phalangeal joints and he could not extend them.

A radiograph was taken at once and showed a fracture of the ulnar styloid and evident misplacement of the carpal bones, especially of the scaphoid and semilunar.

He was then anæsthetized in the operating room. The whole extremity including the elbow was thoroughly shaved and scrubbed with soap and water, lime and soda and alcohol, successively, and the small wound was then excised including a bit of lacerated muscle. A temporary dressing was then applied to the wound and traction and counter traction employed. This was continued for several minutes before any manipulation was attempted and after a moment the deformity disappeared and the hand could be moved easily in all directions and the fingers could be easily extended. Hence simple traction apparently had brought about a good reduction without any manipulation.

A suture was placed in each end of the wound. Boric ointment and a sugar-tong moulded plaster splint extending to the middle of the fingers were applied. The reduction appeared most secure with the wrist in slight flexion. The man was tested for hypersensitiveness and then given tetanus antitoxin.

The diagnosis then was compound fracture of the styloid process of the ulna, forward dislocation of the semilunar bone, and anterolateral displacement of the scaphoid with a general lateral shift of the whole carpus except the semilunar.

Films taken the next day indicated a good reduction and this was confirmed by the appearance and comfort of the patient.

The subsequent course was quite uneventful. The splints were left off on the ninth day, giving him a simple bandage. He has had frequent massage, heat, and light active motion consistently. The paræsthesia has not even yet entirely disappeared, especially in the thumb and index finger, and he has occasionally burned his finger with a cigarette.

On January 12 of this year, while riding in a hunt, his horse again fell in jumping and the patient was thrown to the ground. Both of his wrists were damaged and deformed in this fall. When seen by the reporter that same evening he evidently had a left Colles's fracture with typical marked deformity and a fracture of both bones of the lower right forearm just above the wrist. The fractures were reduced under an anæsthetic. There was no evidence of any new carpal injury. Films made the next day showed an apparently good reduction of both extremities and bore out the clinical diagnosis of a Colles's fracture (left) and fracture of the lower extremities of the radius and ulna on the right side. There was an oblique comminuted fracture

through the lower end of the right radius and a comminuted fracture of the lower end of the right ulna. The fragments were in good position.

Doctor Hanford emphasized again the great advantage of continuous, steady, prolonged traction and counter traction with complete relaxation in reducing fractures and some dislocations of the extremities. Such prolonged continuous traction often eliminates much of the manipulation commonly thought necessary for reduction.

### FRACTURE OF RADIAL SCAPHOID

Dr. Roderick V. Grace presented two cases, the first being a man, thirty years of age, who was injured two and one-half years ago by falling on the outstretched right hand. He was examined within twenty-four hours after injury. He complained of pain and almost complete disability through the right wrist region. On examination there was swelling over the anatomical snuff box and all motions were painful and extremely limited, especially extension. There was marked tenderness over the right scaphoid. This was most noticeable with the wrist in ulnar flexion.

Diagnosis of fracture of the right scaphoid was made and confirmed by an immediate X-ray. The fracture was transverse and through the body of the bone. There was no separation of the fragments. The wrist was immobilized with anterior and posterior moulded splints extending from the fingers to the elbow with the thumb abducted and included in the splint. These splints were removed eight weeks later and patient's further treatment consisted of massage given as often as he could report to the clinic. He wore a wrist strap for protection. Three months later he was able to do full work. At the end of two and one-quarter years his motion is almost completely recovered, there is no pain—although that was his principal initial symptom. Recent X-ray shows bony union.

The second patient presented was a man, approximately thirty years of age. Two and one-half years ago he was injured. The incidents of the injury are too hazy to get an accurate history. He complained of pain and disability in the left wrist. Physical examination showed local tenderness over the left scaphoid, especially with the hand in ulnar flexion. There was almost complete loss of power and function in the wrist. X-ray taken at this time showed a transverse fracture through the scaphoid with a displacement. It was splinted within twenty-four hours of his accident in the usual manner and splints were not removed until eight weeks had elapsed. He reported for full duty within four months of his injury. A recent examination shows his functional and symptomatic result to be perfect. His power is excellent and X-ray taken of his wrist shows bony union to be present.

### FRACTURE OF THE CARPAL SCAPHOID

Dr. Roderick V. Grace read a paper with the above title for which see page 752.

Dr. William Darrach remarked as regards pathology that it seemed simpler to him to consider injuries to the proximal row of the carpus in one group. The injury is usually due to a fall on the outstretched hand. It is believed that with the amount of extension at the wrist, the line of force is not transmitted through the metacarpal but is received on the distal row of the carpus. If the wrist is abducted, the scaphoid is then squeezed between the os magnum and the radius. Without the abduction the line of force is more apt to

involve the semilunar. He did not remember seeing the association of the fractured metacarpal with an injury to any proximal row of the carpus.

There is one symptom which he believes useful in differentiating between fractures of the scaphoid and other injuries in the neighborhood. Direct tenderness is an indefinite sign because in a normal wrist one can usually obtain a certain amount of tenderness by pressing in the snuff box. If pressure is made over the tuberosity of the scaphoid, the lower end of the radius being firmly held, sudden sharp pain will be noticed in most cases of fracture of the scaphoid, while sprains and injuries to the styloid of the radius do not usually give tenderness with this movement.

The results of treatment by prolonged immobilization with thumb held in abduction, have been much more encouraging than they were before the thumb was immobilized. If the thumb is allowed free motion the distal fragment of the sigmoid is apt to move with it. Following the advice of Doctor Speed during the last year, the position of slight flexion has been used for immobilization in order to relax the anterior ligaments through which the major part of the blood supply reaches the scaphoid. He agrees with Doctor Grace that early cases should be treated conservatively and the operative treatment reserved for late cases with pain. Operative results in his experience showed relief from pain in the majority of cases with almost complete restoration of power, but with distinct limitation of motion at the wrist. He has tried removing the whole scaphoid in a few cases but does not yet feel assured that the results are much better than removal of the proximal fragment alone. When the semilunar is displaced forward with the proximal half of the scaphoid, removal is apt to result in a greater increase in abduction and adduction than when the proximal fragment of the scaphoid alone is removed.

Early massage and movements seem to have been given a thorough trial and he believes that a much larger percentage of cases are treated in this way than those treated by immobilization for eight weeks.

DR. JAMES N. WORCESTER said he thought the question of treatment by prolonged immobilization is doubtful.

Even with union shown in the X-ray he has seen cases with a great deal of discomfort. He thinks cases that do have pain should have operative treatment with the entire removal of the scaphoid and that the most important part of the treatment is immediate motion following removal of the fragments. He disagreed with Doctor Darrach in that cases operated on have had very early relief from pain which is what most of them want. They have had increased function but less power, and, in his experience, in cases of removal of the scaphoid with a perfectly free joint and with absence of pain there was still some loss of power in the grip. As already stated some will get well if we don't do anything. A number of these cases, just as in Colles's fracture cases, are difficult if they have an element of arthritis or synovitis. In this lesion there is a possibility of a combination of arthritis and synovitis, and in a number of these cases it is not to be wondered at that the individual has not only displacement but a good deal of pain.

DOCTOR WORCESTER does not like to operate on fracture of the scaphoid unless it is proven that other methods are of no help, and before doing an open operation he found that manipulation of the wrist will sometimes release adhesions, restore power and give relief from pain.

DR. JOHN M. HANFORD said that, based on the statistical evidence, it seemed to him immobilization was the best treatment for acute cases. In the presence of the excellent results that have been shown he was in accord with Doctor Grace in accepting these results as indicating prolonged immobilization as the ideal treatment for acute cases.

DR. RODERICK GRACE closed the discussion by the statement that to put the scaphoid in a position of palmar rest, he personally adopted the cock-up position as this was the hardest functional position of all for the patient to attain in case of non-union. He felt in these cases, since most of them were working men, that if they elected to start with the cock-up position they would obtain better functional results.

## THE USE OF IODIZED RAPE-SEED OIL (CAMPIODOL) FOR RÖNTGENOGRAPHIC EXPLORATION *

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Those of us living and practicing during the latter part of the nineteenth century witnessed the rapid progress of general surgery. We were privileged to observe the results of the development of cellular pathology, of bacteriological technic, and the transition from antiseptic to aseptic surgery. Without the contributions of Virchow, Pasteur, Koch, and Lister, we would still be practicing the surgery of the eighteenth century. With the progress of surgical technic, there slowly developed modern methods of precision in diagnosis. The great surgeons of the last century were known for their "surgical skill", "surgical instinct", and their "surgical touch". These watchwords have done much to retard surgical progress. Medicine, as a whole, has been slow to accept instruments of precision. The stethoscope and the clinical thermom-
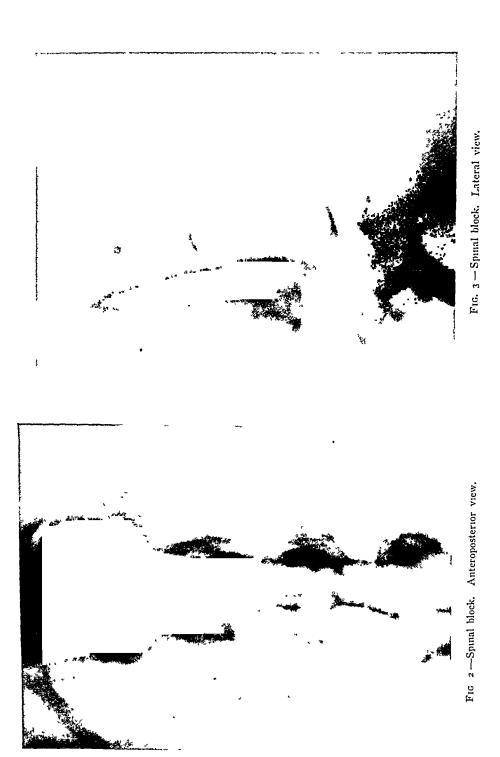


Fig. 1.—Spinal subarachnoid space of a dog after cisternal injection of one and one half cubic centimetres of campiodol.
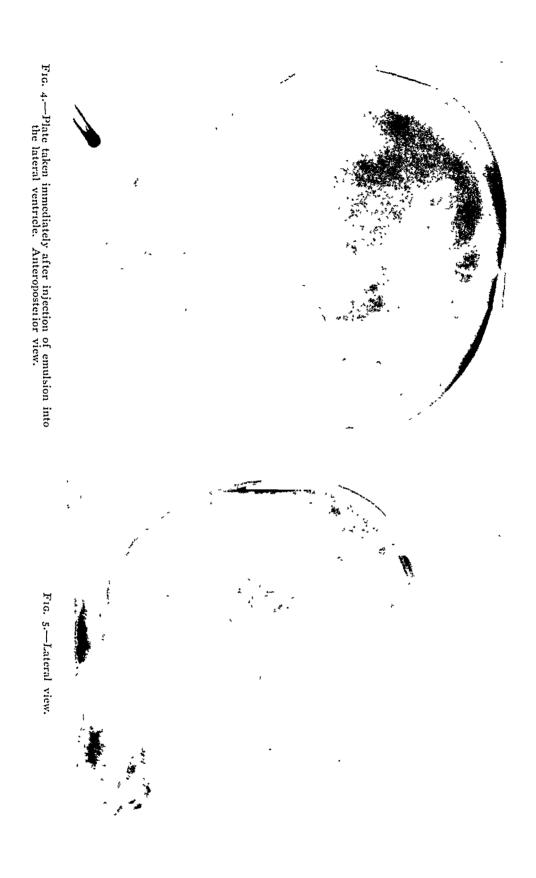
eter were early examples. Even when Röntgen demonstrated the value of the X-ray, and for years afterward, surgeons were loath to depend upon its use and were more tempted to elicit crepitation of the fragments after fracture. With the more general acceptance of the use of the X-ray in diagnosis, we have observed the exploration of the intestinal tract, of the kidney pelvis, of

* Read before the Philadelphia Academy of Surgery, March 4, 1929.

FIG. 3.—Spinal block. Lateral view.

FIG 2.—Spinal block. Anteroposterior view.

Fig. 4.—Plate taken immediately after injection of emulsion into the lateral ventricle. Anteroposterior view.

Fig. 5.—Lateral view.

FIG. 7 —Lateral view.

FIG. 6 —Anteroposterior view three hours later. Diffusion into opposite ventricle.

the cerebral ventricles, and of the subarachnoid spaces. In order to make available the results of X-ray investigation, it is necessary to utilize methods which will permit contrast shadows.

In the intestinal tract this has been obtained by the use of the barium meal. As yet this is not entirely satisfactory. In the small intestine the fragmentation of the meal makes interpretation highly unsatisfactory. For ventriculography and encephalography air has been used. These procedures require considerable time and are not entirely devoid of danger. In the kidney pelvis sodium iodide has proved quite satisfactory.

With the introduction of the iodized poppy-seed oil for röntgenographic exploration by Sicard and Forestier,[1] in 1923, the röntgenologist had added a valuable adjunct to his armamentarium. Realizing the important, although limited, use of the iodized oils in cerebrospinal visualization, my interest was aroused in the subject. The results of our preliminary experiments have been reported by Glaser[2] and myself elsewhere.

After investigating various elements in solution and incorporated with oils, we were convinced that iodine was the most suitable element
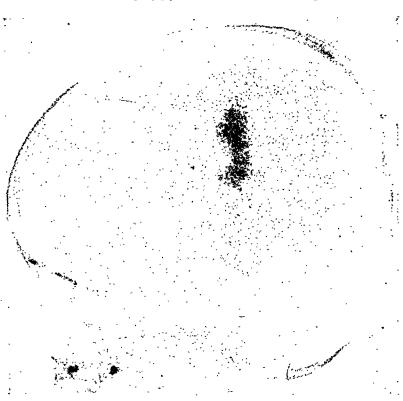


Fig. 8.—Forty-eight hours later. Disappearing of the oil.

for use where shadow-casting properties were desired. The solutions of iodine, iodides, iodates, or periodates were unsuitable for general use. Some of these were well tolerated in the kidney pelvis where they could be drained after röntgenography, but they gave rise to toxic phenomena when injected into the subarachnoid space. We found that the iodized oils as a group were much better tolerated wherever used. Many oils were investigated during the work and we concluded finally that rape-seed oil, which is obtained from Brassica campestris, was the most suitable for general purposes. This oil, which comes from the family of Cruciferas, is non-irritating when injected into the subarachnoid space. It has a low specific gravity (0.913) and is of low viscosity (250 at 100° F). It is well tolerated in large amounts regardless of the site of its administration. It has been employed for cerebrospinal, pulmonary, urological, vascular, and sinus visualization.

For routine work we have used a mixture of four parts of iodized rape-

seed oil (specific gravity 1.289) with one part of ethyl olive oil. The specific gravity of this combination is 1.061. Ethyl olive oil is much less toxic as a diluent than olive oil when used for cerebrospinal visualization. To this preparation the chemists have given the name campiodol.

When, after a careful neurological examination, doubt exists as to the presence or absence of spinal block, this can be demonstrated by the injection of iodized oil. Figure 1 is an illustration of the spinal subarachnoid space of a dog after the injection of campiodol. This animal was alive and well four months after the injection. Figures 2 and 3 illustrate the use of the oil in a case of spinal block. After the injection of the oil, either by lumbar or cisternal puncture, we observe the flow by reversing the position of the patient on the fluoroscopic table. An advantage of iodized rape-seed oil is its lack of globulation and its free flowing properties. It shows no tendency to adhere to the spinal roots, which property in some of the iodized oils gives rise to the so-called false block.

In the demonstration of the cerebral ventricular system we have met with many difficulties. We had hoped to be able to prepare a pseudo-emulsion with cerebrospinal fluid which would diffuse itself throughout the ventricles after injection. Various dilutions of the oil have been used, but we have not as yet obtained a shadow as good as that obtained by air injection. We have since tried campiodol emulsions using a highly purified acacia in the smallest possible amount. In a recent case (Figs. 4, 5, 6, and 7) we obtained an excellent ventricular shadow. The emulsion injected into one ventricle rapidly diffused into the opposite ventricle and was found twenty-four hours later



Fig 9 —Spinal sac forty eight hours after ventricular injection of the emulsion

in the lower portion of the spinal subarachnoid sac. (Figs. 8 and 9.) In some instances there has been a marked increase in cerebrospinal pressure after the injection, doubtless due to the osmotic effect of the acacia. This aspect of the problem is intriguing, but will require further investigation before we would advise its use as a substitute for air ventriculography.

Vascular visualization has been attempted by a number of investigators (Moniz,[3] Brooks,[4] Carnett[5]) but, for numerous reasons, has not been exten-

sively employed. The use of any material which is to any extent irritating is contraindicated. In peripheral vascular disease they may lead to further thrombosis and subsequent gangrene. Campiodol was so well tolerated by the delicate subarachnoid tissues that we have used it for demonstrating the circulation of the cranial and peripheral vessels. We have frequently injected as much as five cubic centimetres without any untoward effect. Doctor Lacey has used this method as a graphic check after vascular occlusion in his study of experimental non-union and has subjected a number of animals to two or more injections. It would be supposed that the injected oil would give rise to fat embolism, but we have never observed such phenomena in our experimental work. In this instance an animal was used which had had a subarachnoid injection by cisternal puncture six months previously. Figures 10 and 11 demonstrate the vessels of the dog's and of the cat's hind leg. This method of vascular photography has many possibilities and will no doubt find a wide field of usefulness. Figure 12 is



FIG. 10.—X-ray (positive) picture of vessels of dog's hind leg.

an X-ray of the dog's head after an injection of the oil into the carotid artery.

The X-ray picture must be taken at the time of the injection of the oil since within one minute after injection nearly all traces of the oil have disappeared. We are not quite sure as to the method of disposal of the oil after injection, but we are sure that oil embolism has not occurred.

In the lung the bronchoscopist has made use of iodized oil as a contrast media for some time. The iodized oils have aided in the interpretation of certain pulmonary disorders much as has the barium meal in gastro-intestinal disease. The necessity of utilizing a substance which is non-irritating to the sensitive alveolar mucous membrane prevented the use of any substance not well tolerated. Figures 13 and 14 are X-ray pictures of the chest after the injection of iodized rape-seed oil into the bronchi of a patient suffering from bronchiectasis. It shows clearly the dilated and "clubbed" bronchi. At the

present time this method is the best at our disposal for determining the extent of the lesion.

Occasionally, the surgeon wishes to ascertain whether or not there exists a stricture in the common duct after operations for the removal of a stone. At the University Hospital campiodol has been introduced both into the gall-bladder and into the common duct, when an external biliary fistula exists, in
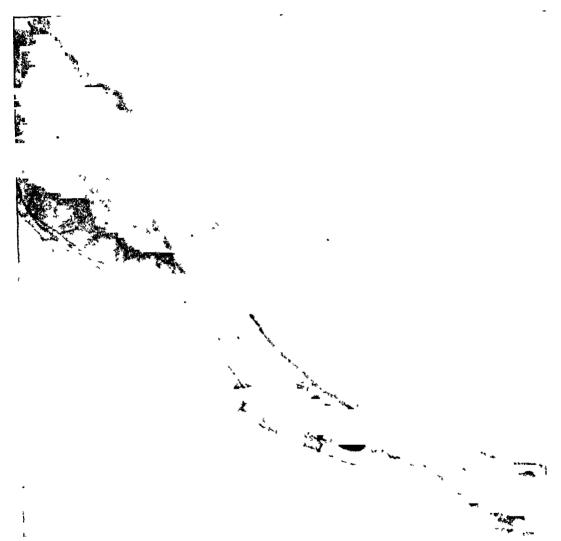


Fɪɢ 11 —X ray picture of hind leg of cat after inject on of campiodol into the femoral artery.

order to determine the patency of the cystic and common ducts. Figure 15 shows an injection of the common duct of a cat with campiodol. The oil has not only entered the duodenum, but it has entered the intrahepatic bile ducts and clearly outlined them.

The oil may be used to advantage to determine the route and origin of old sinus tracts. Figure 16 was taken from a case of Dr. E. L. Eliason's. The oil can be seen clearly entering a large cyst, probably of pancreatic origin.

The gynæcologist has used iodized oils in order to determine the patency of the Fallopian tubes and the urologist for outlines of the kidney pelvis.

We have applied the oil in the experimental laboratory in an attempt to visualize non-opaque pelvic calculi. Doctor Muschat has been able to demonstrate these by injecting the iodized oil and then withdrawing it. Sufficient of the oil remains then to cast a shadow outlining the calculi. In urologic practice the application of oil in this way should be of material advantage.

In sinus disease the iodized oils have a wide field of usefulness in the hands of the otolaryngologist. The demonstration of new growths, polypi, and thickened mucous membrane can be more easily and accurately made than by any other technic.

The question naturally arises, are these oils after iodinization inert? We have given dogs from six to seven cubic centimetres per os of undiluted campiodol per kilo of body weight without any untoward symptoms. The studies we have made on dogs, and those made by Doctor Raiziss on smaller laboratory animals, have led us to conclude that straight iodized rape-seed oil, diluted or not with ethyl olive oil, is less toxic than a solution of sodium iodide containing a similar amount of iodine. The straight oil contains 40 per cent. of iodine. The cell count of the spinal fluid after subarachnoid injection of the oil has varied in the dog from 250 to 800 per cubic millimetre. The highest count
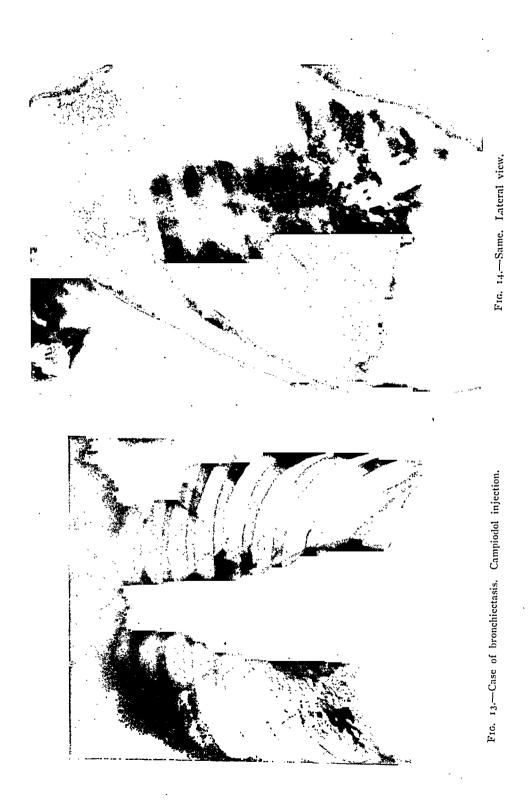


Fig. 12.—Injection of campiodol into the carotid artery of the living dog.

obtained after the injection of the oil into the human subarachnoid space has been 310 cells per cubic millimetre.

We have had no untoward effects after the injection of the oil into the peripheral vascular system, and the procedure has been carried out many times. In fact the only reactions observed have been after injections into the ventricles. The iodine is very slowly liberated and then in very small amounts. In a patient into whose ventricles campiodol had been injected four months

Fig. 14.—Same. Lateral view.



Fig. 13.—Case of bronchiectasis. Campiodol injection.

previously, we were unable to find any free iodine in the cerebrospinal fluid, although X-ray pictures still showed opacity produced by the iodized oil.

Here, however, the problem is complicated by the introduction of another factor, since in the ventricular injections we have felt obliged to use an emulsion. Up to the present time we have not found an ideal emulsion and this phase of the problem is still under investigation.

It is our belief at this time that in iodized rape-seed oil, campiodol, we have as inert a material as it is possible to obtain for shadow-casting purposes when injected into the internal organs. Its high iodine content, the stability of the iodine linkage to the oil, and the fact that rape-seed oil contains very little of the acids which are irritative in character, makes it an ideal product.

We are deeply indebted to Dr. George Raiziss, of the Dermatological Research Laboratories, for his aid in this work.

CONCLUSIONS

1. The iodized oils have a definite use in the rontgenographic exploration of some of the internal organs.

2. Iodized rape-seed oil, campiodol, has proven a highly satisfactory preparation for this type of exploration.



FIG 15 —Injection of the extra and intrahepatic biliary system with the iodized rape seed oil   The oil can be seen entering the duodenum.

3. It is well tolerated by all types of tissue.

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DISCUSSION: DR. DAMON B. PFEIFFER said that a recent experience had made him realize the need of a less irritating material than lipiodol for use in the diagnosis of chest diseases. Briefly, it concerned a young man with bron-

chiectasis of the lower lobe of the left lung, very like one of the pictures shown by Doctor Frazier. One year ago he had a bronchiectasis abscess which ruptured into the pleura, resulting in a massive empyema for which a rib resection was done. Since that time he has been trying to secure closure of a number of bronchial fistulas. Phrenicectomy and local collapse of the chest wall have been tried without avail. The speaker finally considered radical



Fig. 16.—Iodized rape-seed oil after inject on into an abdominal sinus.

extrapleural thoracoplasty and asked the bronchoscopist to introduce lipiodol for information as to the condition of the lower lobe. He did it skilfully, the picture was satisfactory and the information also, but the boy, who had up to that time been producing only small amounts of exudate, began to discharge large quantities of pus from the fistulas, showing that the lipiodol was extremely irritating in its action. Archibald and others have called attention to the irritation of lipiodol and this contribution of Doctor Frazier's may be of first importance in providing a substance which may be used to obtain valuable information not only in the lung but in various other cavities and sinuses without the liability to cause an exacerbation of the underlying conditions. The speaker wished to ask Doctor Frazier whether campiodol is generally available at this time.

# NON-UNION OF FRACTURES *

## AN EXPERIMENTAL STUDY

### By James T. Lacey, M.D.

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AIDED BY A GRANT FROM THE HARRIET M. FRAZIER FUND FOR RESEARCH IN SURGERY

THE causes of non-union of fractures have been widely discussed. Generally, they are divided into two groups—systemic and local. Nearly every writer on this subject mentions syphilis, rachitis, bone dystrophies, bone tumors, osteomyelitis, and countless other general affections. Peterson [1] and Taylor [2] have many followers of the theory of calcium and phosphorous deficiency as the cause of the delay in union. The glands of internal secretion are believed by Marsiglia [3] and Kolondy [4] and others to have a controlling action on bone repair.

Several questions naturally arise in discussing these systemic causes. One must recall the multitude of luetics and rachitics whose fractures heal without delay while, as to the glandular and inorganic salt theories, one wonders why, if these theories are correct, non-union so frequently picks particular sites in the body. Henderson [5] states that constitutional disease is practically never responsible for non-union and, in his series of 259 cases of non-union, the lower end of the tibia and the middle of the humerus stand out as the most frequent sites of non-union. When one excludes non-union of the femoral neck in the aged, these two sites comprise the large majority of the cases observed by the surgeon. Non-union of the clavicle, for example, is rare; yet this bone is probably the most frequent site of fracture. Also against the systemic theory, those cases of multiple fracture stand out in which only one fails to unite. Campbell,[6] Ravdin and Jonas,[7] Ravdin and Morrison,[8] and Henderson [9] could not agree with Peterson [1] that the calcium and phosphorous index could be used as a prognostic index of union or non-union.

It would seem, then, that, if a single cause for non-union were to be found, which I do not believe to be possible, the systemic causes must be discarded in favor of the local causes. Of these, the interposition of soft parts and foreign bodies will not be considered because they are easily remedied and do not belong in the real problem of non-union. In this connection Forrester-Brown [10] states that the periosteum itself, if interposed, will inhibit union. Neither will the malposition of the fragments be considered, for, although they often unite despite the malposition, it is the case of non-union in which alignment and apposition has been good that presents the real problem.

The question of immobilization of the fragments may or may not be a factor. Writers differ on this point, but the movement of the fragments pro-

tected only by a brace for the non-operative treatment of non-union is recommended almost universally for established delayed union or non-union. Henderson [5] mentions inadequate fixation as a cause of non-union in sixty-three per cent. of his 259 cases. Warner,[5] in discussing Henderson's paper, states that rapid union may take place with poor fixation. Thus, the question of fixation does not seem to be the all-important factor.



FIG 1 —A1, sixteen days after fracture There is a moderate external callus formation.

As regards the type of fracture, excluding the fracture similar to the war fracture where loss of bone substance is common, most of the cases of non-union occur in simple fractures. Stern,[5] in discussing Henderson's paper, states that the ordinary compound fracture does not result in non-union. Similarly, a pathological fracture due to osteomyelitis may be seen to unite after drainage has been instituted, while pathological fractures associated with metastatic malignancy often unite.

Essential to the repair of any injury is the blood supply to that part. In the repair of simple fractures, Blaisdell and Cowan [11] summarize four points: (1) The periosteum is more or less lacerated, stretched, and loosened from the bone; (2) the blood vessels in the vicinity of the fracture line are ruptured and closed by clots; (3) the processes of repair are in part modified by the state of nutrition. Robinson,[12] describing the vascular changes at the fracture site, states that the inter- and intra-osseal vessels are ruptured by the fracture and promptly thrombose. The clot formed between the fragments is replaced by granulation tissue into which blood vessels grow transverse to the long axis

of the bone. These new vessels are outbuddings from the vessels about the fracture site. Kolondy [13] states that the endosteum is not able to participate in the repair until an anastomosis is formed between inter-osseal vessels of the central portion of the nutrient artery and the metaphyseal vessels. Drinker, Drinker, and Lund,[14] in their perfusion experiments on the blood vessels of the tibia, found that the blood supply was from three sources: (1) Minute periosteal arteries springing from the fascial and muscular twigs that pass near the bone; (2) many moderate-sized vessels entering near the ends of the bone and frequently terminating within the marrow cavity; and (3) the nutrient artery which in the adult tibia may be considered in series with the arteries of Group II. With the nutrient artery ligated, injection of the vessels of the tibia was almost as complete as where the nutrient artery was not tied. Where the nutrient artery alone was injected, the lower end of the bone was not as completely injected. One of their animals happened to have an old fracture of the tibia at the junction of the middle and lower third of the tibia. No twigs of the nutrient artery crossed the fracture line. The bone below the fracture received its blood supply from the periosteal ves-



FIG. 2.—A1, fifty eight days after fracture The bones have united in good position with extensive external callus

sels and from the vessels entering the bone from the lower end. Johnson[15] established very clearly the anatomy of the vascular supply of the tibia. Like Drinker, he divides the supply into three groups, the nutrient artery, the meta-physeal vessels, and the periosteal vessels. He found that the nutrient artery gave the greatest blood supply and was capable of carrying on the supply for the whole tibia. The metaphyseal vessels were almost equal in potency. They supply the entire bone with only slight deficiency in the centre of the shaft. The periosteal vessels, however, he found did not extend below the cortex. Johnson agreed with Peterson's calcium and phosphorous index theory, but

thought more important the vascular network by which these building materials reached the fracture. Eliason,[16] in an experimental study of non-union of the lower third of the tibia, brought out some important features about the anatomy of the lower third of the tibia. The vessels, nerves, and tendons are all compactly enveloped in the deep fascia. Swelling in this area causes



A 2

11 days
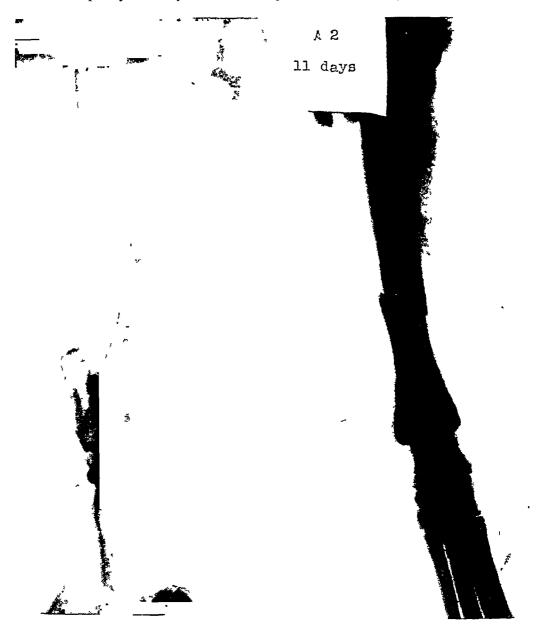
Fig 3 —A2, eleven days after fracture   No evidence of callus formation

a lessening of the dorsalis pedis pulse. The anterior tibial artery lies next to the bone with no intervening muscle, and it is this artery which supplies the greater portion of the blood to the lower end of the bone. In cases of non-union, the affected side is often cooler, the dorsalis pedis pulse weaker, and the blood pressure is invariably lower. The lower fragment shows osteoporosis

and less callus than the upper fragment by X-ray. He fractured the tibias of twelve dogs, four of which were controls, and in eight he ligated the anterior tibial above the fracture site. All united within four weeks, but in five of the ligated dogs, union was less firm and there was less callus as compared with the controls. Campbell [17] mentions severing of the nutrient artery
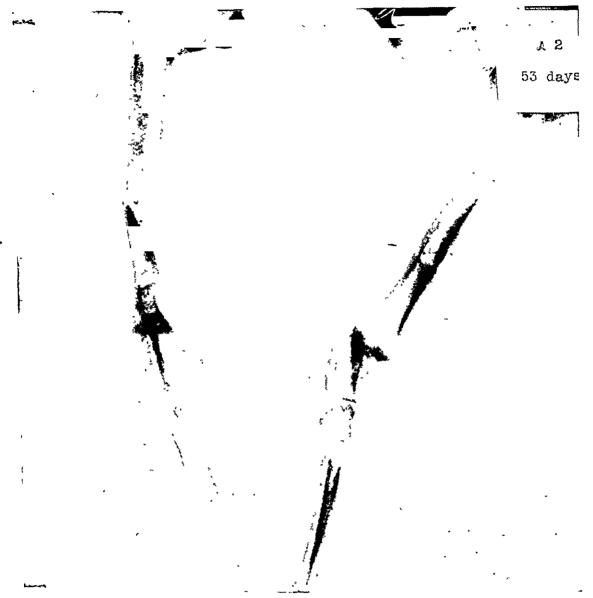


Fig. 4.—A2, fifty-three days after fracture. Slight increase in callus formation, increased density of the bones.

as a cause of non-union. Kolondy [4] injected specimens of fractures and demonstrated beautifully the increased vascular supply at and near the fracture site as compared with a non-fractured bone. Todd [18] states that bone regeneration is easily affected by pressure, even of the soft tissues. Geist [19] showed that a new Haversian system develops in bone after injury about the seventeenth or nineteenth day, at which time the internal and external callus becomes absorbed. Estes [20] gives as one of his causes for non-union insufficient blood supply at the seat of the fracture. Bancroft [21] like Johnson [15] calls attention to the fact that the calcium and phosphorous used in bone repair come from the circulating blood as well as from the ends of the fragments. Nutter [22] and Block [23] mention interference of the blood supply associated with too

tight dressings as a cause for non-union. Kolondy [13] believes that destruction of the periosteal blood supply leads to non-union. His experiments, however, were only continued for forty-two days after fracture. Ely,[24] in his work on the periosteum, agreed in part with Kolondy, but he also considered a fracture ununited after thirty-three days. With this we cannot agree. Henderson [25] included injury to blood vessels, muscles, and fascia as factors in non-union. He believed that hematoma in connection with fractures were a hindrance to union.



Fig. 5.—A2, oil injection after union. The injection shows the anterior tibial artery to be patent throughout.

In summing up this review of the literature, it seems logical to choose the blood supply of the bones as starting point to study the cause of non-union of fractures. Furthermore, it appears that this cause of non-union is to be found at the fracture site and there is nothing more vital to the healing of a fracture than its blood supply. With every fracture, there is a greater or lesser degree of trauma to the soft parts. In Henderson's [5] 259 cases of ununited fractures, 118 were associated with severe trauma. If, then, such fractures occurred in the anatomical sites described by Eliason [16] or were dressed with too tight bandages in addition to the rupture of the intrinsic blood vessels at the line of fracture, there would exist a condition of malnourishment of the distal fragment likely to result in non-union. The foregoing statement gives a condition which is ample cause for non-union. In addition, then, poorly reduced, insufficiently immobilized, and mismanaged fractures are still more likely to be delayed in uniting, or fail to unite at all.

*Method.*—With the study of Eliason in mind, the following experiment was planned. Adult dogs were used throughout. One of the most frequent, if not the most frequent, sites for non-union of fractures—namely, the junction of the middle and lower thirds of the tibia—was chosen as the fracture to be studied. Fracture by operation was selected over closed fracture for sake of accuracy. In the control animals, nothing further was done. In another series, the anterior tibial artery was doubly ligated and cut between the ligatures in addition to fracture of the tibia.

The general technic of the operation was similiar in each case. The operations were carried out with strict asepsis. The entire lower extremity was shaved and prepared with iodine. The anæsthesia in the first few animals was ether. This, however, was discarded in favor of the intraperitoneal injection of sodium amytal. Ample incision was made over the crest of the tibia, and in the controls and ligated animals the periosteum of the tibia was
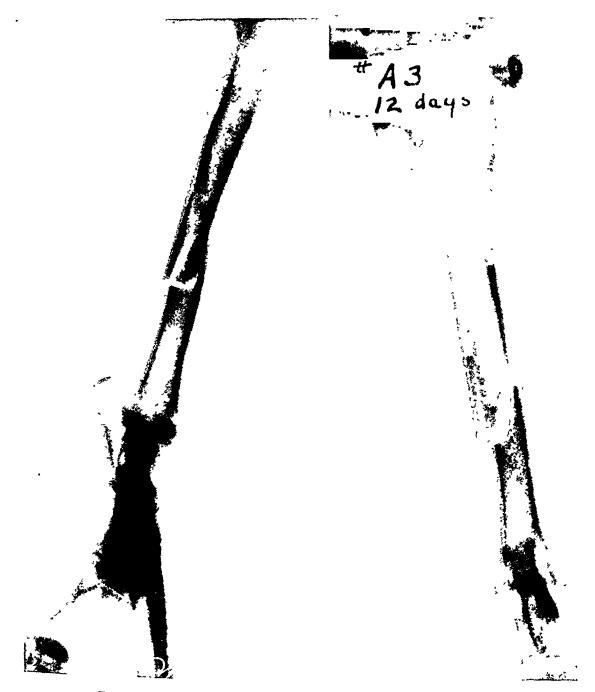


Fig. 6.—A3, twelve days after fracture. No evidence of callus formation.

split longitudinally at the junction of the middle and lower thirds of the tibia. With the periosteal elevator, the periosteum was freed from around the bone sufficiently to allow the bone-cutting forceps to be inserted between it and the bone. The bone was then cut through with the forceps, or nearly cut through and the break completed by manipulation. In the reduction of the

fracture, an effort was made to secure only three-quarters end-to-end apposition. It was found by Ravdin and Morrison [8] that this procedure gave a more satisfactory X-ray picture. The split in the periosteum was then sutured and the fascia and skin closed. Lateral plaster moulded splints were applied from the middle of the femur to, and including, the toes. The splints were allowed to harden before the anæsthesia was discontinued. In the cases in
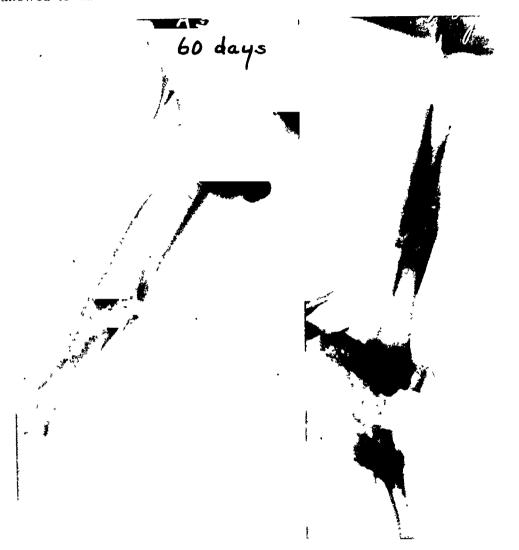


FIG. 7.—A3, sixty days after fracture   The fragments are firmly united with slight absorption of the external callus.

which the anterior tibial artery was ligated, a longer incision was made and the artery isolated at the level of the upper third of the tibia. Two ligatures were passed about the artery and tied and the vessel cut between the ligatures. The splints were removed within a week to ten days after operation in all cases and the wound examined. Immobilization was continued until sufficient callus had formed to hold the fragments together in position. In a very few instances, there was infection in the wound or ulcers developed at distant points due to pressure of the splints. These promptly healed under antiseptic

treatment and in only one instance was the bone exposed. X-ray in this case failed to reveal any evidence of osteomyelitis. The animals were X-rayed two weeks after operation and thereafter every week or two depending on the previous X-ray report.

About the time these experiments were being carried out, campiodol, a new iodized oil, was being prepared under the direction of the Laboratory of
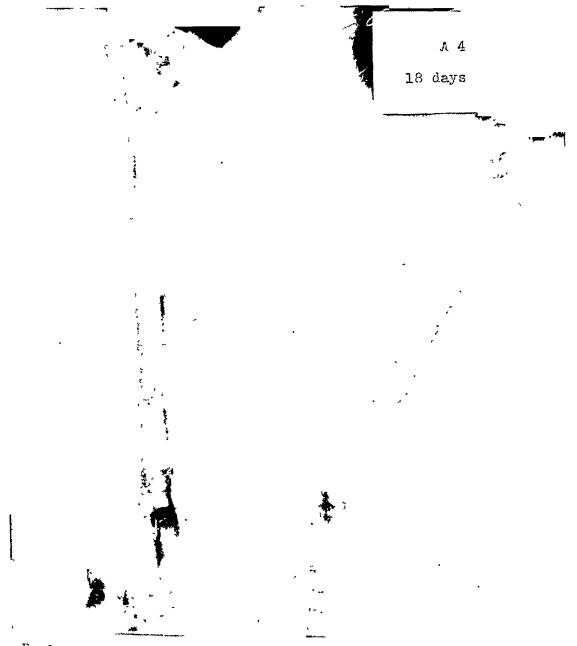


FIG. 8.—A4, eighteen days after fracture. The amount of callus is regarded as abnormally slight.

Research Surgery by Frazier and Glaser.[26] One of the control animals had gone for seventy days without osseous union and it was thought that the anterior tibial artery might have been injured at the time of fracture. To determine patency of this artery, the femoral artery was injected with two cubic centimetres of the opaque oil and an X-ray photograph taken immediately following the injection. (Fig. 5.) A most satisfactory visualization of the vascular tree of the extremity was obtained. Not only was the anterior

tibial artery found to be intact, but also a very extensive collateral circulation was seen about the fracture site. The success of this injection prompted the use of campiodol as a means of controlling future experiments. Accordingly, another animal was operated on, the anterior tibial artery ligated, and the tibia fractured. Injection was done at the completion of the operation while



Fig 9 —A4, forty eight days after fracture  Callus formation is slightly increased.  Presumably there is now definite union

the animal was still under amytal anæsthesia. The information gained from the X-ray of this injection (Fig. 17) showed that the necessary condition described above for the development of non-union had not been accomplished. The lower end of the ligated artery was receiving blood from the branches of the dorsalis pedis artery which anastomosed with branches of the posterior tibial artery. In order to wholly occlude the anterior artery, it was necessary to ligate the dorsalis pedis artery in the foot, thus preventing the collateral circulation through the foot from the posterior tibial artery from supplying the lower fragment.

Up to this point, as shown in Table I, a longer period of time was required for the bony union in the control animals than in the ligated animals. In the next animal (Fig. 19) both the anterior tibial and the dorsalis pedis arteries were ligated and the tibia fractured. The injection shows both ligations. This animal developed the typical picture of non-union as seen clinically by the X-ray. Unfortunately, the animal died under amytal anæsthesia eighty-seven days after fracture and ligation of the anterior tibial and the dorsalis pedis arteries. No evidence of union had taken place and we would interpret this as evidence that union was not going to take place.

From this point all experiments were carried on in a similar manner, i.e., ligation of the dorsalis pedis as well as the anterior tibial artery together with the usual fracture. The results are tabulated in Table I. These results do not appear to be conclusive and considerable explanation is necessary for their interpretation. It will be noted that two of the control animals, A2 and A12[2] required an exceptionally long period of time for osseus union. In the experiments of Ravdin and Morrison,[8] none of their controls took such



Fig. 10.—A6, eighteen days after fracture. The ends of the bones are rather dense. There is no visible callus formation.

a long time to unite. They were using, however, the ulna and radius. The explanation of this may lie in the fact that the lower third of the tibia is normally a very common site for non-union. It is likely, therefore, that in this series such cases were encountered.

To explain why the animals in which the anterior tibial artery was ligated took less time for union reverts to a physiological principle. The effort in this

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problem was to produce a deficient·blood supply to the lower fragment. It was, then, an error in procedure to try to accomplish this by ligating the anterior tibial artery. The blood supply *via* the nutrient artery was cut off by the fracture itself and, as Drinker [14] and Johnson [15] discovered, the metaphyseal vessels alone are sufficient to carry on the nutrition of the lower end of the tibia. If, then, in addition to the injury to the vessels of the tibia itself, the anterior tibial is ligated, the blood normally coursing that artery is shunted to the posterior·tibial through the anastomosis of the foot to the dorsalis pedis and, therefore, increasing rather than inhibiting the blood supply of the lower fragment. Accordingly, early union is to be expected in this group of experiments.

TABLE I

| Group I Controls | | Group II Ligation of anterior tibial | | Group III Ligation of anterior tibial and dorsalis pedis | |
|---|---|---|---|---|---|
| Dog No. | Days for union | Dog No. | Days for union | Dog No. | Days for union |
| A2 | 70 | A1 | 58 | A4 [2] | 87 [1] |
| A9 | 59 | A3 | 56 | A9 [2] | 174 [1,2] |
| A10 | 21 | A3 [2] | 56 | A10 [2] | 66 |
| A12 [2] | 107 | A4 | 48 | A11 [2] | 111 |
| | | A7 | 25 | B1 [2] | 88 |
| | | A11 | 30 | | |
| | | A12 | 30 | | |
| Average | 64 | Average | 43 | Average | 105 + |
| | | | | Average Less A9 [2] | 88 + |

[1] Animal died before union occurred.
[2] Animal living with non-union at completion of problem.

The third group shows more satisfying results. It is obvious from the X-ray of A4 [2] (Fig. 21) that this case is the best example of·non-union in the series and would undoubtedly have progressed for a much longer period of time without union had not the animal died. The tibia·of this dog was removed and cut sagitally. A white line was observed at the fracture site and there was mobility between the fragments. (See photograph, Fig. 24.) Microscopic sections (Fig. 25) revealed that the white line between the fragments was fibrous tissue showing no evidence of invasion of osseus tissue.

A9 [2] is included with reservations. For the first few weeks the animal did very well and, when fibrous union seemed firm enough, the cast was removed. There gradually developed increasing deformity of the fragments, overlapping, and angulation, which may be a factor in the failure of union. The animal is still living and has non-union. Although other works have shown union to occur in equally severe deformities, this animal was not included in the final results. Without including this animal, the average number of days required for union in Group III was twenty-four days plus longer than Group I ·and forty-five days plus longer than Group II.

The terminal oil injection at the completion of the later experiments offers some of the most striking features of the problem. The collateral circulation and anastomoses about the fracture site are astonishing. They show how difficult it is to reduce the blood supply at the fracture site. In dog A10 [2] (Fig. 28), for example, the segment of artery between the two ligatures is seen filled with opaque media. This could only occur with early anastomoses about the ligatures allowing blood to enter the isolated segment before that segment had become obliterated. The original oil injection of this animal, as well as the final, establishes the certainty of the ligations. These abundant anastomoses go a long way toward proving that the blood supply is an important factor in the healing of fractures. A comparison of the final injection of A4 [2] (Fig. 22) with the final injection of the controls, A2 (Fig. 5) and A12 [2] (Fig. 36) and even A10 [2] (Fig. 28) A11 [2] (Fig. 32) and B1 [2] (Fig. 40)—



FIG. 11.—A6, eighteen days after fracture. Microphotograph of the upper fragment close to the fracture site shows considerable amount of external callus.

all of which showed bony union of the fragments—shows the anastomoses of A4 [2] to be much less abundant. This comparison, it seems, helps to establish the theory that interference with the blood supply to a fracture is an important factor in the cause of non-union.



FIG. 12.—A6, eighteen days after fracture. Microphotograph of the lower fragment shows small amount of external callus compared with Figure 11. These sections are equidistant from the line of fracture.

## SUMMARY

An attempt has been made in Group III to produce experimentally a condition similar to a clinical case of non-union. The theoretical clinical case has been described earlier in this paper—fracture at the junction of the middle and lower thirds of the tibia (a very frequent site for non-union) with associated trauma to the soft parts resulting in swelling and compression of the vascular supply to the fragments. The results obtained bear out the theory that occlusion or partial occlusion of the blood supply to the fracture site is an important factor in the production of non-union. Group II, first planned to produce a condition suitable for the production of non-union, shows contrary results, but, in analysis, substantiates the vascular theory.

The use of campiodol for visualization of the vascular tree not only offered an excellent method of control, but substantiated the results of the problem.

## CONCLUSIONS

1. The clinical picture of non-union can be produced in the experimental animal.

2. Interference with the blood supply to the fracture site appears to be an important factor in the development of non-union.
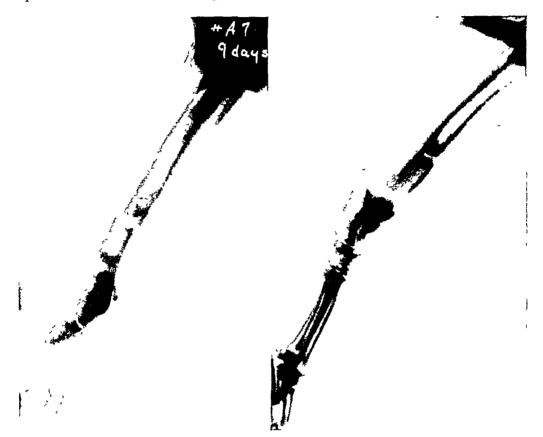


FIG. 13.—A7, nine days after fracture. Moderate callus formation.

3. Interarterial injection of campiodol affords an excellent means of controlling experiments dealing with the vascular system.

The author is deeply indebted to Dr. E. L. Eliason for inspiration, to Dr. I. S. Ravdin for careful guidance, and to Dr. E. P. Pendergrass for interpretation of the X-ray films.

## PROTOCOLS

A1.—Dog, tan and white, long-haired male, medium size. *Operation.*—December 15, 1927, ligation of the anterior tibial artery and fracture of the tibia. December 31, 1927.—Sixteen days after fracture. X-ray: There is moderate external callus formation. January 21, 1928.—Thirty-seven days after fracture. X-ray: Callus is absorbed to some extent. February 11, 1928.—Fifty-eight days after fracture. X-ray: The bones have united in good position with excessive external callus. Experiment concluded.

A2.—Dog, brown, short-haired female, medium size. *Operation.*—December 20, 1927, fracture of the tibia. December 31, 1927.—Eleven days after fracture. X-ray: No evidence of callus formation. January 21, 1928.—Thirty-two days after fracture. X-ray: External callus formation is slight. February 11, 1928.—Fifty-three days after fracture. X-ray: Slight increase in callus formation. Increased density of the bones. February 20, 1928.—Sixty-two days after fracture. X-ray: Practically no change since last examina-
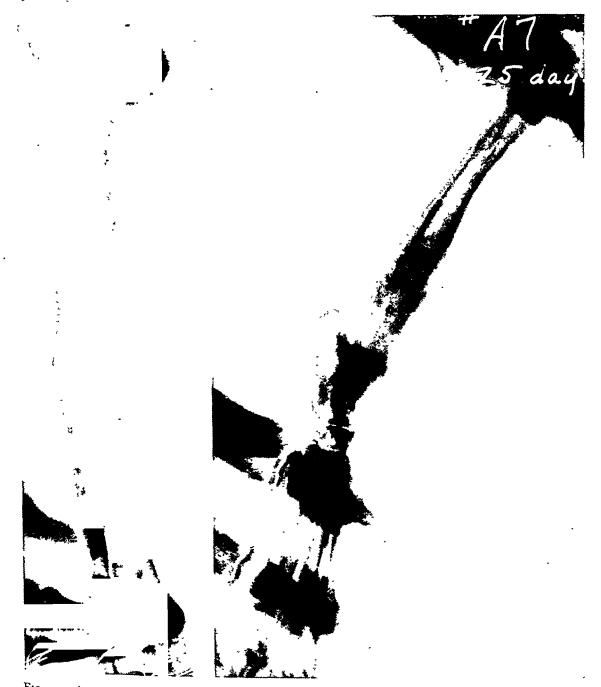


FIG. 14.—A7, twenty-five days after fracture. The bones are firmly united. The callus formation is more marked than in Figure 13.

tion. Slight absorption at the line of fracture. February 28, 1928.—Seventy days after fracture. X-ray: There now appears to be osseous union. March 5, 1928.—Oil injection. X-ray: Excellent injection of the vessels, showing the anterior tibial artery to be patent throughout. Experiment concluded.

A3.—Dog, medium size, tan and white, long-haired female. *Operation.*—December 22, 1927, ligation of anterior tibial artery and fracture of tibia. January 3, 1928.—Twelve days after fracture. X-ray: No evidence of callus formation. January 21, 1928.—Thirty

days after fracture. X-ray: Very slight external callus formation. February 16, 1928.—Fifty-six days after fracture. X-ray: Callus excessive, fragments firmly united. There is increased density of ends of bone, probably due to endosteal bone formation. February 20, 1928.—Sixty days after fracture. X-ray: Fragments are firmly united with slight absorption of external callus. Experiment concluded.

A4—Dog, medium size, tan, short-haired female. *Operation.*—January 3, 1928, liga-



Fɪɢ 15 —A10, thirteen days after fracture. Moderate callus formation

tion of anterior tibial artery and fracture of tibia. January 21, 1928.—Eighteen days after fracture. X-ray: The amount of callus is regarded as abnormally slight. February 11, 1928 —Thirty-nine days after fracture. X-ray: Increase in callus formation, but still not normal. February 20, 1928.—Forty-eight days after fracture. X-ray: The callus formation is slightly increased. Presumably, there is now definite union. Experiment concluded.

A6.—Dog, medium size, black and white, long-haired male. *Operation.*—January 17, 1928, ligation of tibial artery and fracture of tibia at junction of middle and lower thirds February 4, 1928 —Eighteen days after fracture animal died. X-ray: (After death.) The ends of the bones are rather dense. There is no visible callus formation and therefore no evidence of actual union.

A7.—Dog, black and white, short-haired female, medium size. *Operation.*—January 26, 1928, ligation of anterior tibial artery and fracture of tibia at junction of middle

and lower thirds. February 4, 1928.—Nine days after fracture. X-ray: Moderate callus formation. February 11, 1928.—Sixteen days after fracture. X-ray: There is definite increase in callus formation. February 20, 1928.—Twenty-five days after fracture. X-ray: The bones are firmly united in good position. There is more callus formation at this time than at the last examination. February 25, 1928.—Animal died.

A9.—Dog, large, black, short-haired female. *Operation.*—February 10, 1928, fracture of tibia. February 24, 1928.—Fourteen days after fracture. X-ray: Slight bowing of



FIG. 16.—A10, twenty-two days after fracture. Firm union

fragments. No evidence of callus formation. March 8, 1928.—Twenty-six days after fracture. X-ray: Increased density of the ends of the bone. No evidence of union. March 17, 1928.—Thirty-five days after fracture. X-ray: Considerable increase in callus formation. No union. March 29, 1928.—Forty-seven days after fracture. X-ray: Considerable callus, but no union. April 10, 1928.—Fifty-nine days after fracture. X-ray: Osseous union. Experiment concluded.

A10.—Dog, medium size, female, white with tan spots. *Operation.*—February 10, 1928, fracture of the tibia. February 24, 1928—Fourteen days after fracture. X-ray: Moderate callus formation. March 3, 1928.—Twenty-two days after fracture. X-ray: Firm union. Experiment concluded.

A11.—Dog, brown, long-haired female, medium size. *Operation.*—February 15, 1928, ligation of anterior tibial artery and fracture of tibia. February 28, 1928. Thirteen days after fracture. X-ray: Very slight amount of callus. March 8, 1928.—Twenty-one days
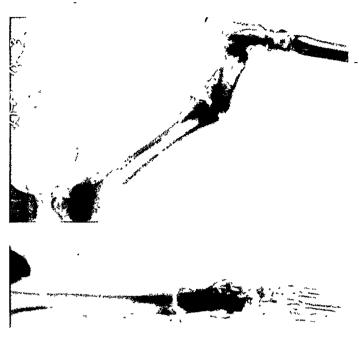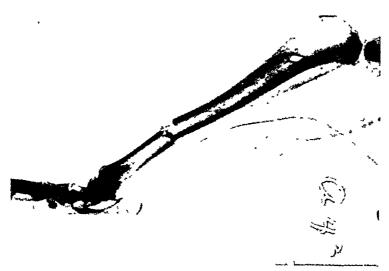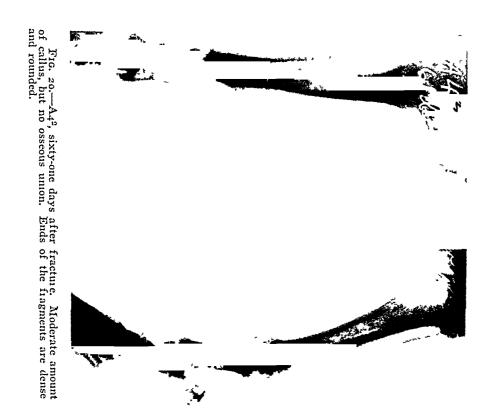
Fig. 18.—A3², fifty-three days after fracture. Probable osseous union, slight rarefaction of the opposing ends of the bone.



Fig. 17.—A3², original oil injection. Injection shows ligation of the anterior tibial artery. There is, however, oil in the lower portion of the anterior tibial artery, evidently due to the collateral circulation.

Fig. 19.—A4², original oil injection. The vessels are shown very distinctly. The anterior tibial and dorsalis pedis arteries are seen to be ligated and, apparently, there is no collateral circulation as evidenced by lack of oil in the vessels.



Fig. 20.—A4², sixty-one days after fracture. Moderate amount of callus, but no osseous union. Ends of the fragments are dense and rounded.

after fracture. X-ray: Evidence of external callus and, possibly, union. March 17, 1928.—Thirty days after fracture. X-ray: Fragments are united. Experiment concluded.

A12.—Dog, white and brown, long-haired male, medium size. *Operation.*—February 15, 1928, ligation of anterior tibial artery and fracture of tibia. February 28, 1928.—Thirteen days after fracture. X-ray: Slight external callus. March 8, 1928.—Twenty-one days after fracture. X-ray: There is considerable external callus and a haziness of the fracture outlines suggesting union. March 17, 1928.—Thirty days after fracture. X-ray: Fragments united in good position. Experiment concluded.
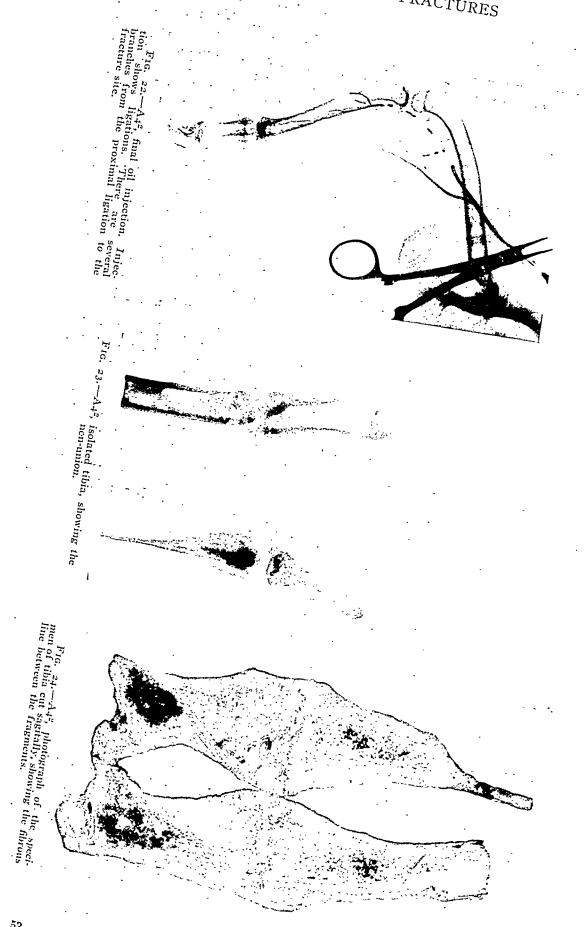
A3$^2$.—Dog, tan and white, long-haired female, medium size. *Operation.*—June 28, 1928, ligation of anterior tibial artery and fracture of tibia. Campiodol injection of femoral artery. X-ray: Excellent injection of the vessels, showing ligation of the anterior tibial artery. · There is, however, oil in the lower portion of the anterior tibial artery evidently due to collateral circulation. July 19, 1928.—Twenty-one days after fracture. X-ray: Moderate amount of external callus with bowing of the fragments. August 2, 1928.—Thirty-five days after fracture. X-ray: Callus has increased, but there is no osseous union. August 10, 1928.—Forty-three days after fracture. X-ray: No osseous union. Considerable callus. August 23, 1928.—Fifty-six days after fracture. X-ray: Probable osseous union—slight rarefaction of opposing ends of bone. Experiment concluded.

A4$^2$.—Dog, tan, short-haired female, medium size. *Operation.*—July 9, 1928, ligation of anterior tibial and dorsalis pedis arteries. Fracture of tibia and campiodol injection of femoral artery. X-ray: Injection of the vessels shows very distinctly. The anterior tibial and dorsalis pedis arteries have been ligated and apparently there is no collateral circulation as evidenced by the lack of oil in the vessels. July 31, 1928.—Twenty-two days after fracture. X-ray: Slight callus present, but no union. August 10, 1928 —Thirty-two days after fracture. X-ray: Increased callus formation, but no osseous union. August 23, 1928.—Forty-five days after fracture. X-ray: No evidence of osseous union, extensive callus formation, ends of fragments becoming rounded. September 8, 1928.—Sixty-one days after fracture. X-ray:



Fig. 21.—A4$^2$, eighty days after fracture. This photograph presents the typical picture of non-union.

Moderate amount of callus, but no osseous union. Ends of fragments denser and more rounded. September 17, 1928.—Seventy days after fracture. X-ray: No osseous union. September 28, 1928.—Eighty-one days after fracture. X-ray: Non-union. October 2 1928.—Eighty-seven days after fracture. Femoral artery injected with four cubic centimetres of campiodol and instantly X-rayed. X-ray: Injection shows ligation. There are several branches from the ligated proximal artery to the fracture site. October 3, 1928.—Animal died.

A9$^2$.—Dog, black, short-haired female, large size. *Operation.*—September 12, 1928, ligation of anterior tibial and dorsalis pedis arteries. Fracture of the tibia. Campiodol

Fig. 22.—A4², final oil injection. Injection shows ligations. There are several branches from the proximal ligation to the fracture site.



Fig. 23.—A4², isolated tibia, showing the non-union.



Fig. 24.—A4², photograph of the specimen of tibia cut sagitally, showing the fibrous line between the fragments.

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injection of the femoral artery. X-ray shows ligations of anterior tibial and dorsalis pedis arteries. October 16, 1928.—Thirty-four days after fracture. X-ray: Slight angulation—slight callus formation. October 30, 1928.—Forty-eight days after fracture. X-ray: Angulation increased, slight callus, no osseous union. November 9, 1928.—Fifty-eight days after fracture. X-ray: Callus increasing, no osseous union. November 25, 1928.—Seventy-four days after fracture. X-ray: No osseous union. December 6, 1928.—Eighty-seven days after fracture. X-ray: Fragments nearly at right angles, no osseous union. January 3, 1929. —One hundred fifteen days after fracture. X-ray: No osseous union. January 19, 1929. —One hundred thirty-one days after fracture. X-ray: No osseous union. February 1. 1929. —One hundred forty-three days after fracture. X-ray: No osseous union. March 4, 1929.— At the completion of the problem, the animal was still living with non-union, one hundred seventy-four days after fracture.

A10[2].—Dog, white and tan, medium size. *Operation.*—October 2, 1928, ligation of dorsalis pedis and anterior tibial arteries and fracture of tibia. October 16, 1928.—Fourteen days after fracture. X-ray: Beginning external callus formation. October 30, 1928.—Twenty-eight days after fracture. X-ray: There is moderate callus formation, but no osseous union. November 9, 1928.—Thirty-eight days after fracture. X-ray: Considerable external callus, but no osseous union. December 3, 1928.—Fifty-two days after fracture. X-ray: No osseus union. December 3. 1928.—Fifty-two days after fracture. X-ray: No osseous union. December 17, 1928. Sixty-six days after fracture. X-ray: Firm osseous union. December 18, 1928.—Oil injection shows ligation of anterior tibial with anastomoses from the ligated stump to the fracture site. Experiment concluded.

A11[2].—Dog, brown, long-haired female, large size. *Operation.*—October 5, 1928, ligation of anterior tibial and dorsalis pedis arteries. Fracture of the tibia. Oil injection of femoral artery. X-ray: Injection shows ligations. October 16, 1928.—Eleven days after fracture. X-ray: No evidence of callus formation. October 30, 1928.—Twenty-five days after fracture. X-ray: Slight external callus formation. November 9, 1928.—Thirty-five days after fracture. X-ray: No osseous union. There is some



FIG. 25.—A4[2], low power microphotograph of specimen showing the fibrous tissue between the fragments with no osseous invasion.



FIG. 26.—A4[2], high power of Figure 25, showing the fibrous tissue and a portion of the osseous tissue at the margin of the fibrous band.

clubbing of the fragments and slight callus formation. November 25, 1928.—Fifty days after fracture. X-ray: External callus formation increased. Ends of bone quite dense. December 6, 1928.—Sixty-three days after fracture. X-ray: Considerable callus, but no union. December 26, 1928.—Eighty-two days after fracture. X-ray: Fibula probably united, tibia ununited. January 12, 1929.—Ninety-nine days after fracture. X-ray: Moderate callus. Union appears to be taking place. January 21, 1929.—One hundred six

FIG. 27.—A10², twenty-eight days after fracture. There is moderate callus formation but no osseous union.

FIG. 28 —A10², sixty six days after fracture, final oil injection. This photograph shows the ligations of the anterior tibial and dorsalis pedis arteries. Note the opaque material in the anterior tibial artery over the fracture site. Note also the extensive anastomoses from the proximal ligation.

FIG 29—Ant. original oil inject on This injection shows ligations
of the anterior tibial and dorsalis pedis arteries

days after fracture. X-ray: Beginning union of tibia. January 26, 1929.—One hundred eleven days after fracture. X-ray: Tibia united. Oil injection shows extensive collateral circulation from the ligated anterior tibial artery. Experiment concluded.

A12².—Dog, white and brown, long-haired male, medium size. *Operation.*—October 16, 1928, fracture of the tibia. Oil injection of femoral artery. X-ray shows the anterior tibial and dorsalis arteries patent and without ligations. November 9, 1928.— Twenty-four days after fracture. X-ray: There is moderate external callus formation. November 25, 1928.—Forty days after fracture. X-ray: Excessive callus formation, but no union. December 5, 1928.—Fifty days after fracture. X-ray: Beginning union of
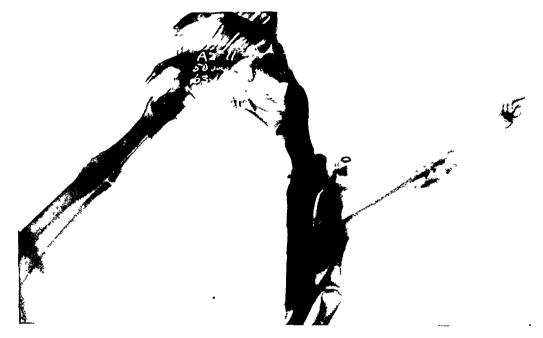


FIG. 30.—A11², sixty-three days after fracture. Considerable callus, but no union.

fibula. December 26, 1928.—Seventy-one days after fracture. X-ray: Fibula united, tibia ununited. January 12, 1929.—Ninety days after fracture. X-ray: No evidence of union of tibia. January 21, 1929.—Ninety-seven days after fracture. X-ray: No change since last examination. February 1, 1929.—One hundred seven days after fracture. X-ray: Tibia united. February 8, 1929.—Oil injection. X-ray: The anterior tibial artery is normally outlined with opaque solution. If this dog has had a ligation of the vessel in the foot, there has been no interruption of the blood around the site of the fracture. Experiment concluded.

B1².—Dog, brown, curly-haired male, large. *Operation.*—October 23, 1928, ligation of anterior tibial and dorsalis pedis arteries. Fracture of the tibia. October 25, 1928.— Oil injection. X-ray: The injection is not very satisfactory, but shows the ligation of the dorsalis pedis artery. November 16, 1928.—Twenty-four days after fracture. X-ray: Slight external callus formation. December 3, 1928.—Forty-one days after fracture. X-ray: Slight increase in callus formation. December 6, 1928.—Forty-four days after fracture. X-ray: No evidence of union. December 20, 1928.—Fifty-eight days after fracture. X-ray: Fibula united, no union of tibia. January 5, 1929.—Seventy-four days after fracture. X-ray: Tibia still ununited. January 21, 1929.—Eighty-eight days after fracture. X-ray: Tibia united. February 1, 1929.—Oil injection. X-ray: Shows ligation with extensive collateral circulation from the proximal ligation. Experiment concluded.

FIG. 31.—A11², one hundred and six days after fracture. Non-union of the tibia.

Fig 32 —A11², one hundred and ten days union of tibia, final oil injection showing extensive anastomosis and collateral circulation from the ligated anterior tibial artery

Fig 33.—A12, original oil injection showing anterior tibial artery patent throughout



Fig 34.—A12, fifty days after fracture. No union of tibia. Beginning union of fibula
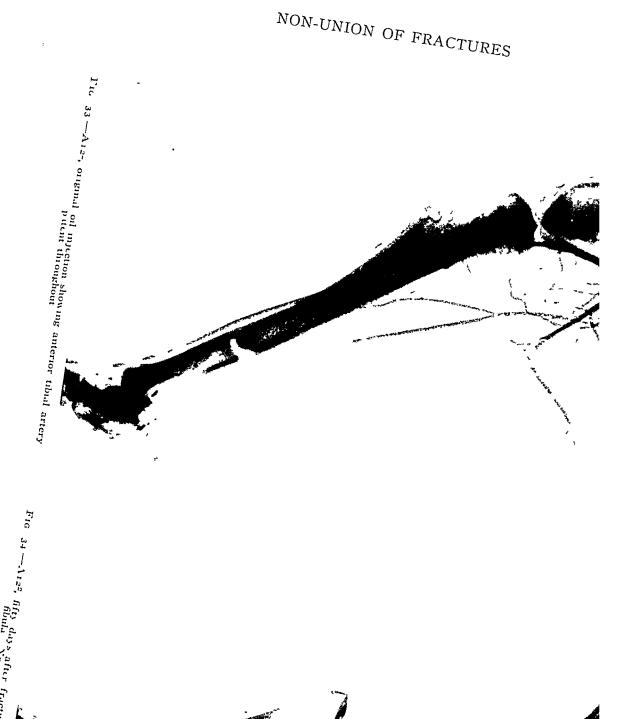
FIG. 35.—A12², one hundred and seven days after fracture. Tibia united.

Fig. 36.—A12², final oil injection. Anterior tibial artery patent. Some anastomosis about the fracture site.

FIG 37 —B1², original oil injection shows ligation of the dorsal s pedis artery, but the injection is not very satisfactory.
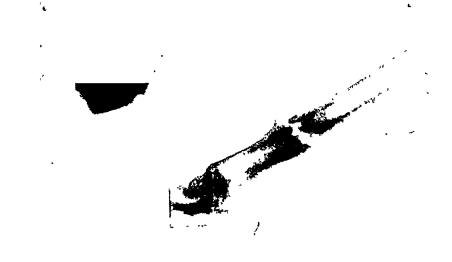
FIG. 38.—B1², forty-one days after fracture. Slight external callus formation.



FIG. 39.—B1², eighty-eight days after fracture  Tibia united

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DISCUSSION.—DR. ELDRIDGE L. ELIASON said that it has been supposed for years that faulty fixation, faulty approximation, and faulty blood supply were the three causes of non-union. All three may be causes, but they are relative with regard to the bone involved. The clavicle is an example of this. Here we often have faulty fixation and faulty approximation and yet very seldom is it the site of non-union. On the other hand in fractures of the lower third of the tibia in which it is extremely easy to get fixation and in which wide separation of the fragments is very unusual, we frequently find delay and non-union. The blood supply of the fragments may be, and usually is, influenced by the position and character of the fracture.

Doctor Lacey has turned his attention toward the blood supply to the exclusion of every other factor. In doing the work, he brought up the question as to whether any investigation should be done on blood calcium and blood phosphorus. He thought probably not, because of the fact that this had been done previously and because, if done, the subject should be considered from the standpoint of the individual fracture, namely, of the shaft of the humerus, the lower third of the tibia, and in some instances of fracture of the junction of the lower third of the radius. The blood supply in these cases is reduced and consequently also the local calcium and phosphorous.

FIG. 40—B12, final oil injection shows ligation of anterior tibial and dorsalis pedis arteries with extensive collateral circulation of the ligated anterior tibial.

The speaker believes that the clinical application of this study is to the effect that we must protect the blood supply. If, for example, in fractures of the lower third of the tibia, we put on a shoe-top extension or a St. Clair skate with straps uniting across the dorsum of the foot, or if we apply a plaster case encircling the foot, the dorsalis pedis artery may be pressed upon and the already meagre blood supply be further reduced. It should make us careful to observe the blood supply of the dorsalis pedis and if there is any constriction or swelling from our dressing it should be relieved and we should apply our traction either through skeletal attachment or by means of plaster splints rather than encircling ones.

# THE EFFECT OF IODINE AND THYROID FEEDING ON THE THYROID GLAND *

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### and

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Last year one of us (W. B. M.)[1] published the results of a series of thyroid and iodine feeding experiments. In that study our conclusions were drawn from three groups of animals. In all groups preliminary biopsy was practiced. Group I comprised animals in which ten minims of Lugol's Solution were added to the diet daily for six weeks at the end of which time biopsy was again done. After a rest period of several months, a section of the thyroid was again removed for study. Group II consisted of animals in which thyroid was given in increasing quantities until the animals exhibited
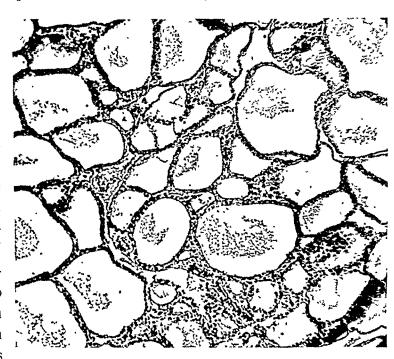


Fig. 1.—Low power normal thyroid gland of dog.

symptoms of hyperthyroidism. A section of the thyroid was then removed and Lugol's Solution was given for six weeks when a third section was taken and, after a rest period of three months, a fourth section was taken. In Group III, thyroid extract was continued for the six-week period that the animals of Group II received iodine.

From this study we were led to agree with the conclusions of Marine that iodine stimulated the cells of the thyroid acini to produce colloid. The newly-formed colloid caused compression of the cells. The effect of iodine (Lugol's Solution) and thyroid extract on the experimental animal were apparently not distinguishable. The prolonged administration of iodine or iodine and thyroid extract apparently resulted in a microscopic picture of thyroid exhaustion.

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* Read before the Philadelphia Academy of Surgery, March 4, 1929.

These studies led us to disagree with Plummer's theory on the effect of iodine on the course of hyperthyroidism. While Plummer believes that the toxic goitre probably secretes a deiodized thyroxin and that iodine exerts its beneficial effect by supplying the iodine radical to this substance, we have felt and are more convinced that the beneficent effect of this drug is due to its effect on the seat of production of the thyrotoxic substance. We believe that the investigations of Kunde [2] and Badger and Sturgis [3] have proven that iodine has no effect on the circulating thyrotoxic substance. Further, Harrington has synthetized thyroxin with incomplete saturation of iodine and Gaddum,[4] in studying these partially deiodized thyroxins, found that as a whole they did not exhibit a similar effect on the metabolism.

It was decided, because of some variation in the typical iodine effect in some animals of the first series, to reproduce the experiment, from a slightly different angle and with more careful attention to the feeding of the animals and the keeping of different groups in separate rooms. It was felt that with more careful control of experimental conditions, the histological picture of the specimens removed would probably not show the variations observed in a similar rotation of drug administration.

## PROBLEM AND METHOD

The purpose of the experiment was to observe the histological effect in three groups of animals.

Group I.—Effect of iodine feeding.

(a) Normal gland.
(b) Histology after twelve weeks of iodine feeding.
(c) Histology at end of rest period of nine weeks.
(d) Histology after thyroid feeding for twelve weeks.
(e) Rest period of nine weeks.

Group II.—Effect of iodine and thyroid feeding.

(a) Histology of normal gland.
(b) Histology after twelve weeks' iodine feeding.
(c) Histology after a rest period of nine weeks.
(d) Histology after thyroid feeding for twelve weeks.
(e) Rest period of nine weeks.

Group III.—Final effect of iodine feeding.

(a) Histology of normal gland.
(b) Histology after twelve weeks of iodine feeding.
(c) Rest period for indefinite period, during which time biopsy should be taken to observe the final effect of the iodine feeding.

The feeding experiments were begun in April, 1928, and the work was continued until February, 1929. While the animals in Group II were receiving thyroid extract, they exhibited certain symptoms of hyperthyroidism, that

is, a loss of weight, tachycardia, and a moderate diarrhœa. No attempt was made to study the basal rate.

All biopsies were removed under strictly aseptic precautions under ether anæsthesia. In order not to confuse the microscopic picture, the sections were removed from first one lobe and then the other, and from opposite poles, when the same lobe was operated on subsequently. This we felt would permit of sections for study in which the trauma of a previous operation could be avoided.

*Histological Studies.* —The microscopic picture of the sections removed from the normal animals before feeding are practically the same. The acini vary in size and in the amount of colloid they contain. The cells lining the acini are of a cuboidal type with large dark-staining
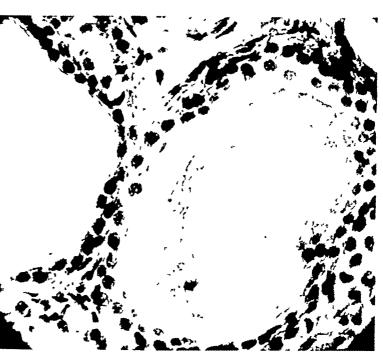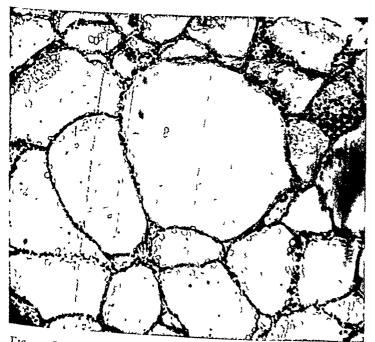


FIG. 2 —High power normal thyroid gland of dog.

nuclei. There are here and there between the acini a moderate number of interstitial cells. (Figs. 1 and 2.)

The typical iodine effect was obtained in every animal. The acini are now distended with colloid. The cells are flattened and elongated. The cytoplasm seems to have disappeared to a large extent and the flattened nuclei appear to form a limiting membrane from the next acinus. There is a marked reduction in the number of in-



FIG. 3 —Low power of thyroid gland of dog after twelve weeks of thyroid feeding.

terstitial cells. (Figs. 3 and 4.) After the first rest period the histologic picture varied somewhat. In some sections the cells became cuboidal again, the acini were not as distended and the interstitial cells increased. In others, the iodine effect seemed to have continued, and in one to have progressed, while in another

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(N83) the picture was that of early exhaustion atrophy in small areas, while the typical iodine effect persisted in others.

After the second period of iodine feeding we did not observe the same iodine effect as after the first twelve weeks of iodine feeding. The acini are moderately distended with colloid. Some of the lining cells of the acini are flattened while others are cuboidal, but as a whole, the cell markings are not as distinct. There was again a decrease in the interstitial cells. (Fig. 5.)
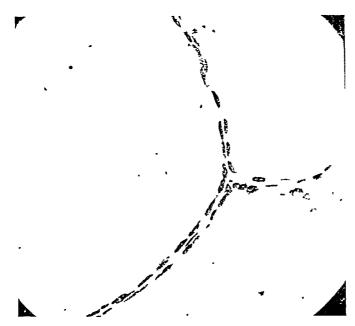
The sections removed from the dogs after twelve weeks of thyroid feeding following iodine and rest were very interesting. In these we find moderate distension of the acinus with colloid, but not sufficient to produce the typical iodine effect. There is considerable variation in their size. In some fields, however, the cell lining has



FIG 4 —High power of thyroid gland of dog after twelve weeks of thyroid feeding

ruptured and the nuclei stain poorly. In other parts of the same field the cells still show some evidence of the flattening produced by the previous iodine administration and which did not disappear during the rest period. Throughout the section, however, are areas showing some proliferation of the interstitial cells. (Figs. 6 and 7.)

The late sections taken from all the animals were exceedingly interesting. In the animals given iodine
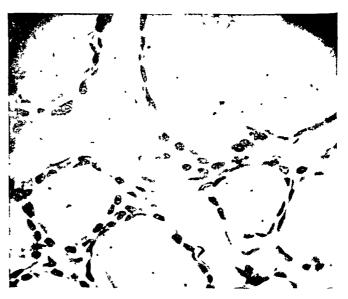


FIG 5 —High power of thyroid of dog after second period of iodine feeding

either for both of the feeding periods or for one feeding period followed by complete rest, the sections show varying degrees of thyroid exhaustion atrophy. In one dog (N87) given only the one period of iodine feeding, the

picture at the end of thirty-three weeks showed complete disorganization of the glandular structure. (Fig. 8.) The picture looks very much like one would expect to see following a thyroiditis. In some places proliferation of fibrous tissue has taken place. The picture is nearly identical with that of Figure 9, taken from a section of human thyroid. The patient, who had exophthalmic goitre, had been given iodine over a number of months. It is extremely interesting to note the recovery which occurred in dog N87 during the second rest period. (Fig. 10.) Here one sees an attempt toward the reformation of acini. Areas of atrophy adjoin fairly-well devel-
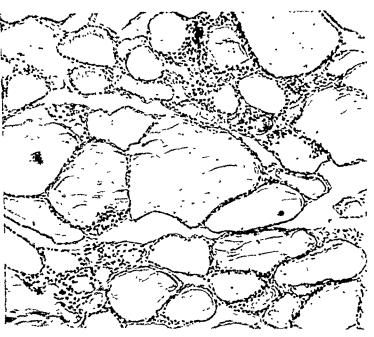


FIG. 6.—Low power of thyroid gland of dog after feeding desiccated thyroid.

oped acini with colloid, while amongst both one can observe cells taking on an acinar arrangement, but in which no colloid is present. The blood supply is markedly increased. This attempt at a return to normal is indeed striking. In other animals the histologic picture showed varying degrees of involution with imperfectly formed acini containing free epithelial cells.

The sections removed from the animals after a rest period subsequent to thyroid feeding showed a marked proliferation of the interstitial cells, with considerable reduction in the size of the acini. (Fig. 11.) This increase in the interstitial cells is much more marked than was



FIG. 7. High power of thyroid gland of dog after feeding desiccated thyroid

observed immediately after the thyroid feeding period.

*Discussion.*—There would seem to be little doubt as to the effect of iodine.

either on the normal or hyperplastic gland. On the normal gland of the dog it causes an increase in colloid formation with a decrease in the interstitial tissue and a striking flattening of the acinar cells. Marine and Williams[5] and Marine and Lenhart[6] have demonstrated that the amount of stainable colloid varied with the iodine content of the gland. Marine further demonstrated that nearly 5 per cent. of a single dose of potassium iodide given to a dog was stored in the gland within a period of two hours after its administration. The effect of desiccated thyroid is not nearly so striking and after these feedings we observed an increase rather than a decrease in



FIG. 8.—Exhaustion of thyroid gland of dog after feeding.

the interstitial tissue. The exhaustion atrophy which was observed in varying degrees after iodine administration appears very similar to the picture one would expect in cases of thyroiditis. The striking thing is the ability of the gland to again take on a somewhat normal picture after a rest period.

Marine[7] states that "a thyroid that has less than 0.1 per cent. of iodine per gram of dry gland cannot be normal, and a gland that has had continuously a content greater than this amount cannot be abnormal anatomically". We have not estimated the iodine content of the dried gland of the dogs fed iodine, but certainly the



FIG. 9.—Exhaustion in the human toxic goitre after prolonged iodine administration.

specimens demonstrate anatomic variations from the normal. Whether these variations are the result of a thyroiditis we cannot definitely state. The sections demonstrate the ability of the thyroid cells of these animals to return to normal when given physiological rest.

The slides from the biopsies after thyroid feeding are somewhat difficult to explain. The partial iodine effect observed in some slides could perhaps be due to the iodine content of the desiccated thyroid gland fed the animals. The sections taken from the animals subsequent to a rest period after thyroid feeding clearly demonstrate hypertrophy. The repeated biopsies may have called forth a compensatory hypertrophy and this may explain why under rest the hypertrophy occurred, while during thyroid feeding it failed to occur. Marine has shown that desiccated thyroid will protect against thyroid regeneration. However, Marine[8] and Loeb[9] differ on the effect of iodine on regeneration. Marine believes
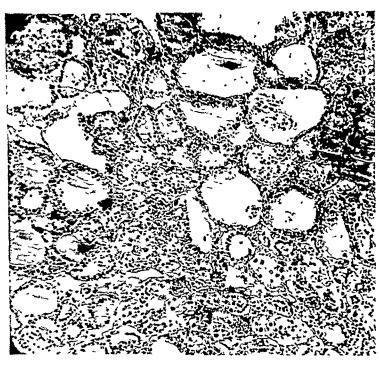


Fig 10.—Low power  Regeneration of thyroid gland of dog during the period of rest following exhaustion

that regeneration will not occur if not more than three-fourths of the dog's thyroid is removed and iodine is administered. Loeb[9] showed that after sub-total thyroidectomy in the dog, iodine not only failed to retard regeneration, but actually hastened it. It may be that Loeb[9] removed more than three-fourths of the gland. Marine[8] states that if more than three-fourths of the gland is removed iodine will not protect against regeneration.

The effect of iodine on the hyperplastic thyroid gland of the human must be due to the ability of iodine to restore the gland temporarily to more normal function. The increased formation of col-



Fig 11 —Low power at conclusion of rest period following thyroid feeding.

loid, compression of the cells and decrease of blood supply are factors that suggest mechanical reduction of thyroid activity. It is reasonable to assume

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that the distorted, compressed cells are incapable of secreting their usual amount of thyrotoxic substance, with consequent clinical improvement.

- It is well known that the clinical improvement from iodine ingestion is often only temporary. This may be explained in various ways. The cells may readjust themselves and gradually regain their ability to secrete; or, as the cells become exhausted, they may also become incapable of producing sufficient colloid to maintain mechanical compression and thus they may release themselves. It is a frequent observation to find a microscopic picture of exhaustion in a toxic goitre removed from a patient after prolonged iodine ingestion—the patient at the time of operation no longer being capable of being beneficially effected by the iodine. The microscopy of these glands, however, would indicate that the gland was inactive. There may be some chemical explanation to explain the beneficent effect of iodine, but we feel certain that Plummer's theory is not the correct one.

### CONCLUSIONS

1. We have confirmed the observations of Marine and of ourselves that ingestion of iodine increases the amount of colloid in the thyroid gland.

2. Colloid retention compresses the cells lining the acini.

3. A stage of exhaustion may occur in the thyroid of the normal dog after prolonged iodine administration, which may be followed by a state of partial recovery during a rest period.

4. A stage of exhaustion occurs in the gland of the human with hyperthyroidism who has taken iodine for a prolonged period. The clinical status of the patient is not proportionate to the histological interpretation.

5. In this study we were unable to confirm our previous findings that the effect of desiccated thyroid was similar to the effect of iodine on the gland of the normal dog.

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# EFFECT OF ABDOMINAL THERMAL APPLICATIONS ON THE INTRAPERITONEAL TEMPERATURE *

## By Selling Brill, M.D.

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THERMAL applications have been used extensively as therapeutic agents since ancient times. There can be no doubt as to their efficacy in the treatment of a variety of clinical conditions. There is, however, some question as to just how they act, especially when applied to the treatment of intra-abdominal lesions. A good deal of evidence has been brought forward to show that heat and cold penetrate fairly readily through the tissues, but there is surprisingly little information in the literature as to the effects of hot and cold applications on the intraperitoneal temperature.



CHART I.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature. Heavy l'nes, Left abdomen (side on which ice bag was applied). Dotted lines, Right abdomen.

Exclusive of the direct effect of abdominal thermal applications on the intraperitoneal temperature, they are of definite use in other ways. The psychic effect on the patient is always beneficial. He knows something is being done for him. There is ample clinical evidence that cold acts as a local anæsthetic agent, frequently relieving pain. Heat applied to the abdominal wall may relieve abdominal cramps and act as a soothing agent, but its direct effect on the intraperitoneal lesion is a debatable point. Many surgeons believe it causes a reflex effect within the abdomen. There is some indirect evidence in support of this. Goldschmidt and Light [1] have shown that, when one arm was surrounded by water of a definite temperature range, reflex responses were found in other superficial areas. At the extremes of temperature the reflex responses were slight. Von Friedrich and Bokor [2] reported that an ice bag placed on the epigastrium caused increased peristalsis. The same effect

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\* Read before the Philadelphia Academy of Surgery, March 4, 1929.

is obtained when cold is applied to other areas of the skin. These investigators conclude that the effect must be due to a reflex mechanism.

There is a divergence of opinion as to whether heat or cold should be used in certain abdominal conditions. In appendicitis, for example, practically everyone uses cold. In pelvic inflammatory diseases, heat is more frequently applied. Some surgeons believe that cold is indicated in peritonitis, while others believe that heat is preferable.
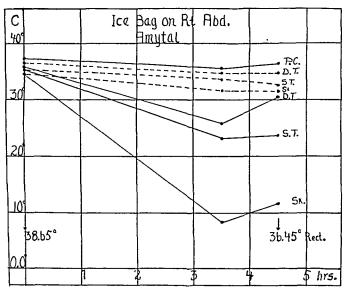
Leyton and Sherrington[3] demonstrated that an ice bag or hot-water bottle applied to the skull might change the intradural temperature through a range of 5° or 6° C. Zondek[4] made observations on the thighs of human subjects, using a fine mercury thermometer introduced through a trocar. He realized there were several sources of error in his method and made corrections for some



CHART II.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature. Heavy lines, Right abdomen. Dotted lines, Left abdomen.

of them. In one experiment he introduced the thermometer obliquely into the thigh for a distance of seven centimetres so that its point was about five centimetres deep. An ice bag applied for one hour over this area lowered the skin temperature from 34.8° to 7° C. and the deep muscle temperature from 37.1° to 36.3° C. MacLeod and his co-workers,[5] working on rabbits and using a thermocouple within a hypodermic needle, were able to show a rise of 4.07° C. in muscle temperature at a
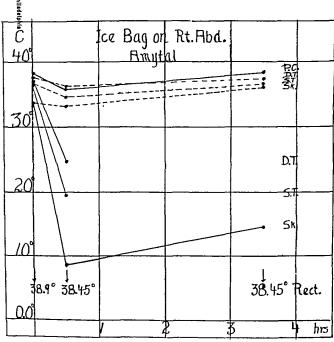


CHART III.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature. Heavy lines, Right abdomen. Dotted lines, Left abdomen.

depth of seventeen millimetres after the application of heat. Stengel and Hopkins [6] passed a thermocouple into the stomach through a duodenal tube. Ice bags applied over the gastric area produced a drop of 1° C. in the course of forty-five minutes, while hot-water bottles had little effect on the intragastric temperature. Zondek [4] introduced his fine thermometer, described above, into the psoas muscle just posterior to the peritoneum. He found that the application of an ice bag over the hypogastrium for two hours produced a drop of 4.5° C. and assumed that this was related to the intraperitoneal temperature. Using an electric pad as their hot applicator, MacLeod and his co-workers [5] found that the temperature just inside the peri-
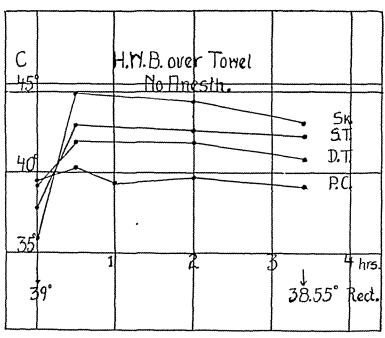


CHART IV.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature.

toneal cavity rose 4° C. This corresponds almost exactly to the rise they found in muscle temperature. The thermocouple was introduced into the abdominal cavity through a hypodermic needle.

*Method.*—The temperature readings recorded in the observations below, unless otherwise noted, were made with the thermo-electric apparatus designed by H. C. Bazett and B. McGlone [7] of the Department of Physiology, University of Pennsylvania, to both of whom I am indebted for much advice and encouragement. Briefly, it consists of two



CHART V.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature.

thermocouples, a constant temperature bath, and a galvanometer. Constantan and iron were used as the thermo-elements for the thermocouples. For deep temperatures a thermocouple of needle type was used consisting of steel tubing through which a properly insulated constantan wire (0.127 millimetre

diameter) was threaded. The diameter of the needle in most of the experiments was 0.46 millimetres; in the last three series of observations it was 0.51 millimetres in diameter.

The observations were made on dogs. The animal was strapped to a table and allowed to lie for some time, usually thirty minutes to one hour, before the experiment was started. The anæsthetic, when one was used, consisted of sodium amytal (sodium iso-amyl-ethyl-barbiturate) given intra-peritoneally. fifty milligrams per kilo. The hair on the abdomen was usually so scanty that shaving was unnecessary, except in a few instances. Room conditions were kept fairly constant.
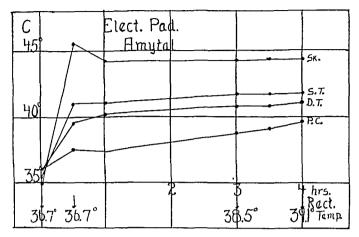


CHART VI.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature.

Readings were made as nearly as possible at the same points. In two of the experiments in which the needle was kept continuously in the abdomen, the needle was introduced into the peritoneal cavity through the lateral abdominal wall, several centimetres distant from the thermal applicator. Otherwise, the applicator was removed to take readings beneath it. Readings of superficial tissues were taken by the introduction of the needle laterally just beneath the skin for a distance of two centimetres. The skin was frequently nicked to allow easier entrance of the
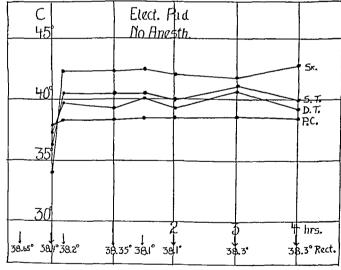


CHART VII.—Sk., Skin temperature. S. T., Superficial Tissue temperature. D. T., Deep Tissue temperature. P. C., Peritoneal Cavity temperature. Rect., Rectal temperature.

needle. In the deep tissue observations, the needle was introduced in a similar manner beneath the deep fascia, usually in the rectus muscle. Peritoneal temperatures were taken by piercing the abdominal wall almost vertically. Once the needle was within the peritoneal cavity, it apparently made little difference to what depth it was introduced. The usual depth of the needle was three to five centimetres from the skin. The cold applicator consisted of ice blocks within a surgeon's rubber glove, making an ice bag of 6 x 12 cm. For

a hot applicator either an ordinary hot-water bottle was used, or an electric pad, 10 x 45 cm. doubled so that the heating surface was 10 x 22 cm.

All the rectal temperatures were taken with an ordinary clinical rectal thermometer.

## OBSERVATIONS

Table I shows intraperitoneal temperatures on a control animal with and without anæsthesia. It will be noted that there was a variation of 0.6° C. in the intraperitoneal temperature, the highest readings occurring just after the dog had voided.

TABLE I

*Dog on table fifteen minutes; abdomen not shaved; needle in abdominal cavity continuously; room temperature—25°C.; no thermal application.*

| Time P.M. | Temperature P. C. Right ° C. | Surface Temperature ° C. | Rectal Temperature ° C. | Remarks |
|---|---|---|---|---|
| 2:00 | | | 38.85 | |
| 2:05 | | 36.4 Rt. abd. | | |
| | | 36.4 Lt.   " | | |
| 2:08 | 38.3 | | | |
| 2:22 | 38.8 | | | Voided |
| 2:27 | 38.8 | | | Voided |
| 2:32 | 38.6 | | | |
| 2:37 | 38.4 | | | |
| 2:42 | 38.6 | | | |
| 2:53 | 38.6 | | | |
| 3:00 | Sodium amytal—500 mgs. intraperitoneally. | | | |
| 3:40 | 38.4 | | | |
| 4:00 | 38.7 | | 38.35 | |

P. C. = peritoneal cavity.

In Table II are shown intraperitoneal temperature readings taken at frequent intervals during the application of an ice bag for one hour. This animal had no anæsthetic. The surface temperature dropped markedly and quickly from 38.8° to 8° C., while intraperitoneally there was a drop of only 0.7 of a degree during an hour.

TABLE II

*Small area on abdomen shaved; needle in abdominal cavity continuously; room temperature—24°-25° C.; ice bag on right abdomen.*

| Time P.M. | Temperature P. C. Right ° C. | Surface Temperature ° C. | Tissue Temperature ° C. |
|---|---|---|---|
| 4:00 | 38.5 | 35.8 Rt. | |
| | | 24.8 Lt. | |
| 4:05 | Ice bag applied—no anæsthetic | | |
| 4:06 | 38.5 | | |
| 4:08 | 38.4 | | |
| 4:12 | 38.4 | 8.0 Rt. | |
| 4:15 | | 34.5 Lt. | |
| 4:19 | 38.4 | | |
| 4:26 | 38.4 | | |
| 4:31 | 38.3 | | |
| 4:36 | 37.7 | | |
| 4:41 | 37.7 | | |
| 4:45 | 37.8 | | |
| 4:50 | 37.8 | | |
| 5:05 | 37.8 | | 19.5 Rt. |

P. C. = peritoneal cavity.

Table III gives observations made on the same dog over a period of five hours. A fall of 2.5° C. occurred within the abdomen. This was the greatest drop in temperature observed in any of the experiments. The rectal temperature fell only 0.75° C. These results are shown graphically in Chart I.

TABLE III

*Dog on table twenty minutes; small area on abdomen shaved; room temperature—24°C.; ice bag on left abdomen; no anæsthesia.*

| | | Control ° C. | Thirty minutes ° C. | Two hours ° C. | Three hours ° C. | Five hours ° C. |
|---|---|---|---|---|---|---|
| Surf. | Rt. | 34.6 | 32.4 | 33.7 | 34.1 | 32.2 |
| | Lt. | 35.3 | 8.2 | 9.7 | 9.9 | 8.3 |
| Sup. Tiss. | Rt. | 37.8 | 35.7 | 31.6 | 31.8 | 32.0 |
| | Lt. | 37.1 | 24.6 | 18.7 | 19.3 | 17.2 |
| Deep Tiss. | Rt. | 37.8 | | 33.8 | 33.7 | 34.2 |
| | Lt. | 37.1 | 26.9 | 24.8 | 26.7 | 22.5 |
| P. C. | Rt. | 39.1 | 37.9 | 36.2 | 36.8 | 36.5 |
| | Lt. | 38.6 | 37.9 | 35.5 | 35.7 | 36.5 |
| Rectal Temp. | | 38.55 | | | | 37.8 |

P. C. = peritoneal cavity.

In another experiment the animal was given sodium amytal as an anæsthetic thirty minutes before the beginning of observations. The rectal temperature fell 2.2° C. in four and one-half hours. The peritoneal cavity temperature dropped only 1.1° C. after the ice bag had been applied steadily for the same length of time. The findings are shown in Table IV and Chart II.

TABLE IV

*Sodium amytal, 575 milligrams intraperitoneally thirty minutes before beginning of experiment; abdomen not shaved; room temperature—22.1°C.; ice bag on right abdomen.*

| | | Control ° C. | Three and one-half hours ° C. | Four and one-half hours ° C. |
|---|---|---|---|---|
| Surf. | Rt. | 34.6 | 8.3 | 11.8 |
| | Lt. | 34.5 | 31.5 | 31.4 |
| Sup. Tiss. | Rt. | 35.2 | 23.0 | 23.7 |
| | Lt. | 35.1 | 33.4 | 32.5 |
| Deep Tiss. | Rt. | 35.9 | 25.9 | 30.3 |
| | Lt. | 36.5 | 34.7 | 34.7 |
| P. C. | Rt.+ | 37.2 | 35.4 | 36.1 |
| | Lt.+ | 37.0 | 35.4 | 36.5 |
| | Mid. | 37.1 | 35.7 | 36.1 |
| Rectal | | 38.65 | | 36.45 |

P. C. = peritoneal cavity.

Table V and Chart III show findings when the control readings were taken before the administration of the anæsthetic. Thirty minutes after the anæsthetic was given and the ice bag applied, the peritoneal temperature was found 2.4° C. below the original reading. Three hours later, however, when the dog was recovering from the effects of the anæsthetic, the peritoneal temperature had returned to its original level although the ice bag had been applied continuously to the abdomen.

TABLE V

*Sodium amytal, 500 milligrams intraperitoneally; abdomen not shaved; room temperature—24°C.; ice bag on right abdomen.*

|  |  | Control before amytal ° C. | Thirty minutes after amytal and cold applied ° C. | Three and one-half hours ° C. |
|---|---|---|---|---|
| Surf. | Rt. | 33.8 | 8.9 | 14.7 |
|  | Lt. | 33.5 | 33.1 | 36.0 |
| Sup. Tiss. | Rt. | 36.1 | 19.6 |  |
|  | Lt. | 36.8 | 34.7 | 36.7 |
| Deep Tiss. | Rt. | 37.0 | 24.9 |  |
|  | Lt. | 37.6 | 36.1 | 37.3 |
| P. C. | Rt. | 38.1 | 35.7 | 38.3 |
|  | Lt. | 38.1 | 36.1 | 38.3 |
| Rectal |  | 38.4 | 38.45 | 38.45 |

P. C. = peritoneal cavity.

The hot-water bottle made an unsatisfactory heat applicator since it lost heat rapidly, necessitating frequent changes of the water. Table VI and Chart IV show *results when the hot-water bottle was applied over a towel, as is usually done clinically. The water in the bottle was kept as nearly as possible to a temperature of 55° C., but probably varied from 50° to 60° C. Observations taken with a mercury thermometer between the towel and bottle gave readings from 44° to 54° C., and between the skin and towel, 40° to 50° C. The dog's skin was slightly burned toward the end of the experiment.

TABLE VI

*No anæsthesia; abdomen not shaved; room temperature—25.9°C.; hot-water bottle over towel, left abdomen.*

|  |  | Control ° C. | Thirty minutes ° C. | One hour | Two hours ° C. | Three hours twenty-five minutes |
|---|---|---|---|---|---|---|
| Surf. | Rt. | 35.6 | 44.4 |  | 38.7 |  |
|  | Lt. | 35.9 | 44.9 |  | 44.4 | 43. |
| Sup. Tiss. | Rt. | 38.4 | 42.0 |  | 39.1 | 38.6 |
|  | Lt. | 37.7 | 42.9 |  | 42.5 | 42.2 |
| Deep Tiss. | Rt. | 38.6 | 40.9 |  | 39.0 | 38.5 |
|  | Lt. | 38.6 | 41.9 |  | 41.8 | 40.8 |
| P. C. | Rt. | 39.2 | 39.6 | 38.8 | 39.0 | 38.5 |
|  | Lt. | 39.3 | 40.3 | 39.2 | 39.6 | 39.0 |
| Rectal |  | 39.0 |  |  |  | 38.55 |

P. C. = peritoneal cavity.

Table VII and Chart V give findings after the application of a very hot water bottle with the animal under anæsthesia. The water in the hot-water bottle and skin was usually 55° C. taken with a mercury thermometer. No towel was used. The dog's

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skin was badly burned. Under these conditions a rise of 2.3° to 2.5° C. was produced intraperitoneally.

### TABLE VII

*Sodium amytal, 600 milligrams intraperitoneally; abdomen not shaved; room temperature—23°–24°C.; hot-water bottle on skin of left abdomen.*

| | | Control °C. | Thirty minutes °C. | One and one-half hours °C. | Three hours °C. | Four and one-half hours °C. |
|---|---|---|---|---|---|---|
| Surf. | Rt. | 34.4 | 41.3 | 40.4 | 47++ | 47++ |
| | Lt. | 34.4 | 42.6 | 41.8 | 47++ | 47++ |
| Sup. Tiss. | Rt. | 35.4 | 39.5 | 38.6 | 40.8 | 41.6 |
| | Lt. | 36.7 | 40.4 | 39.6 | 44.8 | 46.6 |
| Deep Tiss. | Rt. | 36.2 | 38.6 | 38.1 | 39.5 | 41.2 |
| | Lt. | 37.6 | 38.3 | 38.7 | 40.2 | 44.5 |
| P. C. | Rt. | 37.4 | 37.5 | 37.4 | 38.7 | 40.1 |
| | Lt. | 37.6 | 37.5 | 37.4 | 39.3 | 39.9 |
| | Mid. | | | 37.4 | 39.3 | 40.1 |
| Rectal | | 39.0 | | | | 38.8 |

P. C. = peritoneal cavity.

An electric pad of the type previously described was used as the heat applicator in the next experiment. This animal had been under anæsthesia for one and one-half hours before the experiment started. The rectal temperature was 36.7° C., obviously subnormal. It rose to 39.1° C., during the four hours under observation. This factor is important in considering the fairly marked rise in the peritoneal temperature as shown in Table VIII and Chart VI. The rise was 3.5° C., the greatest temperature change found in these observations. The dog's skin was not blistered. The temperature between the skin and pad varied from 44° to 48° C., although between the folds of the pad the temperature reached 80° C. as shown by a mercury thermometer.

### TABLE VIII

*Dog under anæsthesia one and one-half hours before observations were started; abdomen not shaved; room temperature—25.2° C.; electric pad across upper abdomen; chiefly on right side.*

| | | Control °C. | Thirty minutes °C. | One hour °C. | Three hours °C. | Three and one-half hours °C. | Four hours °C. |
|---|---|---|---|---|---|---|---|
| Surf. | Rt. | 34.9 | 42.4 | 44.3 | 44.3 | 44.4 | 44.4 |
| | Lt. | 35.3 | 41.0 | 40.4 | 40.5 | 40.0 | 41.2 |
| Sup. Tiss. | Rt. | 35.4 | 41.0 | 41.1 | 41.8 | 41.7 | 41.8 |
| | Lt. | | | | | | |
| Deep Tiss. | Rt. | 36.0 | 39.5 | 40.2 | 40.8 | 40.9 | 41.1 |
| | Lt. | | | | | | |
| P. C. | R. U. | 36.0 | 37.5 | 37.4 | 38.8 | 39.1 | 39.6 |
| | R. L. | | | | 38.8 | 39.1 | 39.6 |
| | L. U. | 36.1 | 37.4 | 37.4 | 38.8 | 39.1 | 39.6 |
| | L. L. | | | | 38.8 | 39.0 | 39.5 |
| Rectal | | 36.7 | 36.7 | | 38.5 | | 39.1 |

P. C. = peritoneal cavity.  L. U. = left upper.
R. U. = right upper.  L. L. = left lower
R. L. = right lower.

Table IX and Chart VII give the results of an experiment similar to the one just described, but omitting the anæsthesia. It will be noted that in this instance there was little change in rectal temperature and no marked effect on the intraperitoneal temperature.

TABLE IX

*Dog on table thirty minutes; no anæsthesia; room temperature—25° C.; rectal temperature 38.65° C. before placing electric pad across right upper abdomen.*

| | | Control °C. | Ten minutes °C. | One hour °C. | One and one-half hours °C. | Two hours °C. | Three hours °C. | Four hours °C. |
|---|---|---|---|---|---|---|---|---|
| Surf. | Rt. | 34.0 | 42.4 | 42.4 | 42.5 | 42.0 | 41.8 | 42.9 |
| | Lt. | 34.7 | 36.7 | 36.0 | 35.8 | 35.4 | 35.4 | 35.3 |
| Sup. Tiss. | Rt. | 36.3 | 40.5 | 40.5 | 40.5 | 40.0 | 41.2 | 40.0 |
| | Lt. | 36.3 | 37.6 | 37.0 | 37.1 | 37.1 | 36.8 | 37.1 |
| Deep Tiss. | Rt. | 37.3 | 39.7 | 39.3 | 40.1 | 39.3 | 40.6 | 39.3 |
| | Lt. | 36.9 | 37.3 | 37.1 | 37.8 | 37.8 | 37.6 | 37.6 |
| P. C. | R. U. | 37.9 | 38.4 | 38.4 | 38.5 | 38.5 | 38.6 | 38.5 |
| | R. L. | 37.8 | 37.7 | 37.8 | 38.0 | 37.7 | 37.8 | 37.8 |
| | L. U. | 37.9 | 37.8 | 38.2 | 38.5 | 38.0 | 38.0 | 38.1 |
| | L. L. | 38.0 | 37.8 | 37.9 | 38.0 | 37.8 | 37.8 | 37.8 |
| Rectal | | 38.35 | 38.2 | 38.35 | 38.1 | 38.2 | 38.3 | 38.35 |

P. C. = peritoneal cavity.
R. U. = right upper.
R. L. = right lower.
L. U. = left upper.
L. L. = left lower.

In general, when intraperitoneal temperature readings were taken at different locations, no marked difference was observed irrespective of where the thermal applicator was applied. One may assume that, in the dog at least, the temperature in the abdominal cavity normally is about the same throughout. This seems logical if the portal circulation can be considered as the temperature regulator of the abdominal cavity.

Profound narcosis was observed to lower the rectal and intraperitoneal temperatures to a considerable extent in one experiment. In this instance a dog weighing ten kilograms was given 500 milligrams sodium amytal intraperitoneally. This seemed to excite the animal and an hour later a second dose of 250 milligrams of sodium amytal was given. The dog was still restless and noisy, so 65 milligrams of morphine was injected subcutaneously. In a few minutes the animal seemed completely prostrated and the respirations dropped to six per minute. The rectal temperature dropped from 38.9° to 34.5° C. and the intraperitoneal temperature from 38.4° to 33.7° C. The dog later recovered.

In attempting to apply these results clinically, it should be kept in mind that the human abdomen wall is thicker than the dog's and that the fat layer is a poor thermal conductor. Zondek[4] observed a marked difference in the temperature change produced by an ice bag in an obese person as compared to one with a thin, fatty layer. At the same depth in the tissues, the drop in temperature in the fat subject was 1.5° C., and in the thin one 4.5° C.

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### SUMMARY AND CONCLUSION

1. Observations on the effects of hot and cold abdominal applications on the dog's intraperitoneal temperature are presented:

(*a*) Cold applications had little effect on the intraperitoneal temperature, the greatest fall being 2.5° C. which was observed in one instance.

(*b*) Hot applications in the form of a hot-water bottle over a towel, as usually used clinically, did not produce any appreciable changes.

(*c*) An electric pad did not influence the intraperitoneal temperature of the normal animal to any great extent, but in an animal under anæsthesia, with a low rectal temperature, it caused a rise of 3.5° C. intraperitoneally. Coincidentally, the rectal temperature rose 2.4° C.

These observations indicate that the beneficial effects of hot and cold abdominal applications are due to other causes than the effect on intraperitoneal temperature.

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DISCUSSION.—DR. BARTGIS MCGLONE said that the first investigators, Becquerel and Breschet, recognized the necessity of minimizing the systematic error due to the thermal conductivity and capacity of the metals used in the thermocouples. Accordingly, the thermojunction was well imbedded in the tissues. Claude Bernard took similar precautions. Bazett and McGlone have shown that, at a depth of ten millimetres, this error is within the limits of the sensitivity of the portable type of apparatus, if the gauge of the needle thermocouple is of the order of 0.4 millimetres or less. At lesser depths the error must be evaluated and a proper correction made. Doctor Brill has described his technic by which the errors cited are reduced to a minimum. Thus the temperature values which he has obtained are significant. The discrepancy between the results of the experiments reported tonight, and those of the Toronto school, are explicable, since it is possible that the trocar used in the latter work may have been of so great a mass as to effect easily and rapidly thermal changes, a contingency against which Doctor Brill has exercised adequate precautions. In this report there are two outstanding features: The adequacy of the methods which Doctor Brill has employed, and the results which he has obtained.

# BILE PERITONITIS AND BILE ASCITES*

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As EARLY as 1772 James MacLurg[1] found the subject of the bile sufficiently interesting to write a monograph on "Experiments on the Human Bile and Reflections on the Biliary Secretion". Herein he states that: "The experiments suggest opinions, which, by their novelty, captivate the mind and hurry it into theory. In spite of ourselves we are carried into the sea which has so often proved fatal to observers and whose rocks, though frequently pointed out, are so difficult to be avoided. We shall give the reflections as they naturally rise from the subject we have been examining, without searching after any other order."

Although MacLurg's work is now forgotten and is rarely referred to in the older literature, it seems likely that it was the incentive for much of the work which has come after it. Many of the theories which have received experimental confirmation in the last decade are discussed by him with a clarity that is indeed refreshing. Among other views he concludes that in the "coloring and bitter part of the bile has appeared to be the production of the animal septic process".

Bile peritonitis resulting from injury, the slipping of a ligature, or from "extravasation" while not very common, is not exceedingly rare. However, until recently the Continental literature discussed the subject much more frequently than did the English literature.

When one attempts to review the subject of bilious ascites, he is confronted with a mass of conflicting evidence. In some instances, so-called "extravasations" of bile are recorded as evidences of massive bile leakage without toxic symptoms. In others, major ascitic accumulations in the peritoneal cavity resulting from portal obstruction and which are bile-stained from an existing jaundice are reported as evidences of bilious peritonitis, although the history and findings do not substantiate the diagnosis. In fact, in nearly every instance wherever fluid resembling bile has been removed from the peritoneal cavity, the material has been called bile and, from time to time, such evidence has been presented in an effort to demonstrate that bile is non-toxic. Buchanan[2] has stated that the reaction of the peritoneum to bile depends on whether the bile is infected or not.

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Although for some years considerable thought has been directed to the toxic factor in bile, no one has so far as we know attempted to ascertain whether the bile-stained fluid found in the peritoneal cavity in association with obstruction of the common duct is similar in its action to bile. Neff,[3] in a very excellent review of the surgery of the biliary tract, devotes considerable space to "bilious ascites" and apparently draws no distinction between true bilious ascites and actual bile leakage.

The classic symptoms of bile peritonitis are to a degree variable, depending on the extent of the bile leakage, but in the main they resemble an acute or subacute peritonitis. The patient, as a rule, has fever and an increase in the polymorphonuclear leucocytes. There is early marked abdominal tenderness and rigidity associated with varying degrees of distention as the disease progresses. Vomiting occurs early and is persistent. The urine at first shows evidences of an irritative nephritis and later anuria may supervene. Bradycardia is observed early and hypotension with a slow irregular respiration.

*The Toxic Factor in Bile.*—This subject has attracted the attention of investigators for many years. As previously quoted, MacLurg believed that the pigment and salts were probably both responsible. Later it was shown that the intravenous administration of bile from the gall-bladder of the ox caused death. It was then suggested that impurities in the bile gave rise to capillary thrombi after intravenous injection and Bouisson reported that filtered bile did not cause such lesions and death did not result. Henle,[4] no doubt influenced by Bouisson's work, stated that the widespread view of the toxicity of bile was unwarranted.

The discovery of the bile acids by Strecker[5] and the extensive study of the toxicity of the bile salts by von Dusch[6] dispelled the existing conception that impurities in the bile were the cause of its toxicity. Meltzer and Salant,[7] in 1906, and Simon Flexner,[8] in the same year, again demonstrated the toxic action of the bile salts. Flexner showed that they were the cause of the acute pancreatitis which follows the retrojection of bile into the pancreatic ducts.

Other investigators report results at variance with these opinions. Danielewsky[9] and Flint[10] attribute the toxic moiety to cholesterol. Fasciani,[11] however, was unable to confirm the results of these investigators. Rohrig,[12] Traube,[13] de Bruin,[14] and Sellards[15] concluded that the bile acids are responsible for the effects observed after bile injection. King and Stewart[16] and Landois[17] were of the opinion that the bile salts were either feeble poisons, or were non-toxic. King and Stewart,[16] and King, Biglow, and Pearce[18] came to the conclusion that the bile pigments are the toxic agents of bile or at least the major toxic constituent.

The conflicting evidence is no doubt due to variations in technic, the administration of impure constituents, and failure to properly control the experiments. We have had no experience with the free bile acids, but, as far as we know, these are not found in the bile. That the pigment is the toxic factor seems highly unlikely from accumulated clinical and experimental evi-

dence. In the hemolytic anæmias we have observed considerable pigment retention without the symptoms of bile intoxication. Horrall and Carlson [19] have confirmed previous work that the toxic factor of the bile is the bile salts. They also have found no evidence for the assumption that the bile pigment is toxic and they state that "pure bile acids are non-toxic due to their insolubility". They state, and we have confirmed their observations, that when bile was injected in amounts sufficient to cause death in twenty-four hours, the presence of bacteria did not modify its toxicity. The toxic action was not modified by boiling or freezing. The dialysate of whole bile they found to be toxic while the non-dialyzable portion was non-toxic.

We were interested in those patients who have bile-stained fluid in the peritoneal cavity in association with an obstruction of the common duct. These patients differ markedly from patients who have had extensive bile leakage in that they show no signs of a diffuse or diffusing peritonitis. The fluid resembles bile, but the peritoneum does not react to it as it does to bile. In these patients it would seem that either the toxic factor of the bile is absent entirely, or present in only small amounts, or that some unknown factor prevents the toxic fraction from exhibiting its effect.

As a basis for the present work we estimated the bile salts in whole gall-bladder bile, gall-bladder and common-duct fistula bile and bilious ascites. In this work we have used the method of Aldrich and Bledsoe [20] for estimating bile salts, reading against a standard of sodium taurocholate.

*Estimation of Bile Salts in Bile.*—In these experiments we have utilized bile from several sources. Each specimen was sterilized in an autoclave. The human specimens were obtained from patients subsequent to the production of external biliary fistulæ. The first two specimens of dogs' gall-bladder bile were removed some time after death, which may account for their unusually high content of bile salts. The variation of bile salt content in the human specimens is within the limits found by different observers.

TABLE I

| No. | Type of Bile | Sodium taurocholate Grams/100 c.c. | Remarks |
|---|---|---|---|
| 1 | Gall-bladder—Dog No. 1 | 17.6 | Post-mortem |
| 2 | Gall-bladder—Dog No. 2 | 17.4 | Post-mortem |
| 3 | Gall-bladder—Dog No. 3 | 11.0 | |
| 4 | Gall-bladder—Fistula, human No. 1 | 0.8 | |
| 5 | Gall-bladder—Fistula, human No. 2 | 0.5 | |
| 6 | Common duct—Fistula, human No. 3 | 1.10 | |
| 7 | Common duct—Fistula, human No. 4 | 1.12 | |

*Bilious Ascitic Fluid.*—Table II gives the estimation of the bile salts of the ascitic fluids and also the bile pigment content in the blood and ascitic fluid. The pigment was estimated by the van den Bergh method. The striking point in the table is the low bile salt content of the ascitic fluid in comparison with that found in actual bile.

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TABLE II

| Patient No. | Blood | | | Fluid | | |
| --- | --- | --- | --- | --- | --- | --- |
| | van den Bergh | | | van den Bergh | | Sodium taurocholate (Grams/100 c.c.) |
| | Direct | Indirect (Mg./litre) | | Direct | Indirect (Mg./litre) | |
| 1 | Immediate | 33.25 | | Delayed | 18.5 | 0.170 |
| 2 | Delayed | 6.5 | | Delayed | 3.0 | Negligible |
| 3 | Immediate | 44.0 | | Delayed | 7.5 | 0.0065 |
| 4 | Immediate | 10.5 | | Delayed | 4.0 | 0.007 |

The bilious ascitic fluids were obtained from the dog (Fluid No. 1) and from patients (Fluid No. 2, 3, 4). The delayed van den Bergh in the blood in a patient who subsequently showed ductal obstruction is difficult to explain. The report was given to us by the hospital laboratory which sent us the specimen. It may be possible that the obstruction had been released and that the delayed reaction with a low pigment content in the blood was a result of this. The uniformly delayed direct reaction in the ascitic fluid may be explained by the fact that it stood some time before study. Andrewes [21] has



7 c.c. Gall Bladder Bile - Dog

1 c.c. Saline
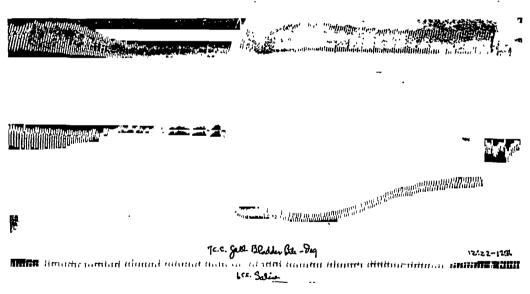
Fig. 1.

shown that a direct immediate reaction becomes a delayed reaction under these circumstances. It would have been interesting to have had the estimation of blood bile salts in these cases and to have compared these with the bile salts in the ascitic fluid. Dragstedt and Spurrier [22] have recently suggested that in obstructive jaundice the formation of bile salts is retarded after complete hepatic secretory suppression occurs. Greene, Aldrich, and Rowntree [23] found that the blood bile salts increased after ductal obstruction for a period of about two weeks when they tended to decrease and return to the normal level. Schalscha and Lande [24] have recently demonstrated a parallelism between the hyper-

bilirubinema and the blood bile salts in mild degrees of hepatic damage. In severe parenchymal damage they found a decrease or a complete disappearance of the blood bile salts.

*Effect of Bile Salts, Bile, and Bilious Ascitic Fluid on Blood Pressure.*— We have found considerable variation in the effect of bile salts in the same concentration and injections of the same bile specimen on the blood pressure of different dogs. In some instances the pressure came back to normal, while in others it remained low or continued to drop, leading eventually to death of the animal. We present (Figs. 1 and 2) the effect on the blood pressure of the same animal of two specimens of bile (dog gall-bladder bile No. 3 and human fistula bile No. 1) as compared with bilious ascitic fluid. The concentration of bile salts in human fistula bile No. 1 was 0.8 per cent., while in the
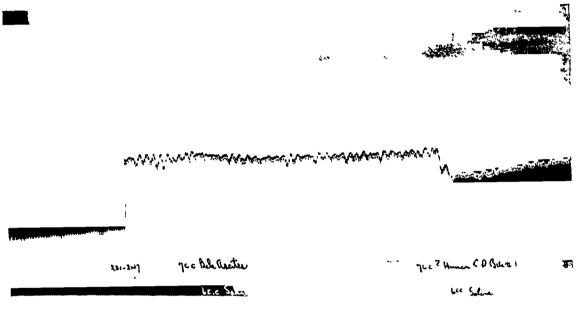


Fig. 2.

dog gall-bladder bile No. 3, the concentration was 11 per cent. In the ascitic fluid the concentration was 0.007 per cent. The fall in pressure varied depending on the bile salt content. There were not sufficient bile salts present in the ascitic fluid injected to alter the blood pressure.

*Effect of Intraperitoneal Injection of Bile Salts on Mice.*—We injected intraperitoneally into mice varying amounts of pure sodium taurocholate. The salt was dissolved in 1 or 1.2 cubic centimetres of distilled water. Control injections of distilled water alone had no effect. (Table III.)

Horrall and Carlson [19] believed that cholesterol acted as a protective agent against the action of bile salts on the blood pressure. They had not studied the effect on mice of intraperitoneally injected bile salt solutions, saturated with cholesterol. We have studied this aspect of the problem and have found no evidence that cholesterol acts as a protective agent against the action of bile salts when used in this manner. (Table IV.) Horrall [25] recently states that apparently lecithin and cholesterol modify the toxic effects of bile salts only slightly.

When whole bile containing calculated amounts of bile salts, similar to those used in the previous injections, was used we found a slightly diminished

TABLE III

*Effect of the Intraperitoneal Injection of Bile Salts on Mice*

| Sodium taurocholate Grams | Death Minutes |
|---|---|
| 0.009 | Lived |
| 0.009 | Lived |
| 0.010 | 95 |
| 0.010 | 300 |
| 0.010 | 420 + |
| 0.020 | 70 |
| 0.020 | 100 |
| 0.020 | 114 |
| 0.030 | 20 |
| 0.030 | 25 |
| 0.030 | 30 |
| 0.030 | 40 |
| 0.040 | 2–3 |
| 0.040 | 14 |
| 0.040 | 18 |
| 0.040 | 21 |
| 0.040 | 26 |
| 0.040 | 30 |
| 0.040 | 49 |

TABLE IV

*Effect of the Intraperitoneal Injection of Bile Salts with Cholesterol on Mice*

| Sodium taurocholate Saturated with cholesterol Grams | Death Minutes |
|---|---|
| .037 | 40 |
| .040 | 7 |
| .040 | 20 |
| .040 | 24 |
| .040 | 28 |
| .040 | 46 |

toxicity. Flexner [8] believed the diminished toxicity of the bile as against pure bile salts was due to the presence of protective colloids. The effect of the intraperitoneal injection of bile is shown in Table V.

TABLE V

*Effect of Bile Injected Intraperitoneally on Mice*

| Calculated Sodium taurocholate Grams | Death Minutes |
|---|---|
| 0.011 | lived |
| 0.022 | lived |
| 0.031 | 126 |
| 0.031 | 240 + |
| 0.033 | 64 |
| 0.037 | 360 + |
| 0.037 | 480 + |
| 0.040 | 71 |
| 0.040 | 120 + |
| 0.040 | 180 |
| 0.044 | 540 + |
| 0.055 | 32 |

The ascitic fluids were used in a similar manner. It was necessary in two instances to concentrate large amounts of the fluids in order to obtain the amount of calculated bile salts which we believed might have any effect on the mouse. Table VI gives the results obtained from the injection of fluids Nos. 1, 3, and 4. It will be seen that the toxic factor, assuming that this factor is the bile salts, was present, but in the concentrations found it is too dilute to cause toxic symptoms in the human.

TABLE VI

|  | Sodium taurocholate calculated Grams | Death Minutes |
|---|---|---|
| Fluid No. 1 | .034 | 14 |
| No. 3 | .0092 | 7 |
| No. 4 | .0175 | 96 |

*Bile Peritonitis and Bilious Ascitic Fluid.*—Horrall and Carlson [19] have found and we have confirmed their observation that five cubic centimetres per kilo of body weight of sterile whole gall-bladder bile of the dog injected intraperitoneally will cause the death of the animal within twenty-four hours. The injection of less than three cubic centimetres did not produce any toxic symptoms.

In the abdominal fluid No. 1, obtained from dog No. 411, we obtained 150 cubic centimetres of the ascitic fluid. A small amount of the fluid may not have been removed, but this amount could not have been more than half again the amount removed. The animal weighed eleven kilos and, based upon this and the fluid removed, it is interesting to note the following:

| Weight of dog No. 411 | = 11 kilos |
|---|---|
| Amount of fluid removed | = 150 c.c. |
| Concentration of bile salts in Ascitic fluid | = .0017 gm. per c.c. |
| Total bile salts in fluid | = 0.255 grams |
| Amount of gall-bladder bile necessary to kill 11-kilo dog | = 55 c.c. |
| Concentration of bile salts in gall-bladder bile | = 0.11 gm. per c.c. |
| Total bile salts necessary to cause death | = 6.05 grams |

Thus the ascitic fluid contains only 4.2 per cent. of the concentration of bile salts necessary to cause the death of the animal.

*Discussion.*—There has been considerable discussion as to whether bile as such can ever gain access into the peritoneal cavity without a perforation of the biliary tract. The opinions are conflicting. Clairmont and von Heberer [26] have apparently published the first experimental work on this subject. These authors recorded a case in which they removed between seven and eight litres of fluid resembling bile from the abdominal cavity of a man who had a large stone in the common duct. No perforation of the biliary passages could be found. Subsequently, as the result of experiments on four dogs, in which they ligated the common duct, and all of which died with intraperitoneal bilious effusion, but without visible perforation of the ducts, they concluded

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that the bilious fluid was the result of increased permeability of the bile tract. This filtration they supposed was the result of a pathologic state of the ducts.

With these experiments we cannot agree. Although subsequent to ligation of the common bile duct in the dog, we have found bile-stained fluid in the peritoneal cavity, we have never encountered bile peritonitis except when a technical error occurred at the time of, or a ligature slipped subsequent to, operation. As the result of a severe inflammation of the extrahepatic bile ducts such an increase in permeability might be conceivable leading to a transudation of bile, but in simple obstruction unassociated with acute inflammation, it seems highly unlikely.

It would seem plausible to liken the common duct and gall-bladder to the ureter and kidney pelvis. The hydronephrosis of uretral obstruction is in many ways analogous to the hydrohepatosis of common-duct obstruction. In the former, after obstruction, one does not observe urinary extravasation into the retroperitoneal tissues even though, at times, the ureter may be seriously damaged during the passage of a stone. Schievelbein[27] agreed with the filtration theory and stated that the channels of Luschka's glands offered a site for the leakage.

Blad[28] believed that bile peritonitis could occur without perforation of the biliary passages and explained the transudation of bile by a ferment action of the pancreatic juice on the gall-bladder wall. Animals developed bile peritonitis after the injection of pancreatic juice into the common-bile duct and the subsequent ligation of it. The gall-bladder wall showed no changes macroscopically, but microscopically a total necrosis with softening of the wall was observed. Ingebrigtsen,[29] in discussing Blad's work, suggested that the bile-colored fluid in the abdomen was the result of a general icterus following ligation of the common duct. It can be assumed that only in a very few of the cases of ductal obstruction does pancreatic juice enter the biliary ductal system by retrojection. The pressure necessary for complete hepatic secretory suppression is greater than that necessary for pancreatic suppression, so that in those instances of ampullary or papillary obstructions bile is more likely to enter the pancreatic ducts than pancreatic juice is likely to enter the common duct or gall-bladder. Furthermore, in the dog, the pancreatic ducts enter the duodenum separately from the common duct, so that in this animal the pancreatic retrojection theory is untenable.

Wolff,[30] Ritter,[31] Burchardt,[32] Meyer-May,[33] and Cope[34] express the opinion that a minute perforation probably offers the nidus for the leakage in those cases in which it is difficult to demonstrate larger perforations. Burchardt[32] concludes that "the occurrence of authentic bile extravasation or bile peritonitis without perforation has not yet been proved". Furthermore, "a more plausible view than the filtration theory is the suggestion that the perforation was not found or already healed". This view is more in accord with our own experimental evidence. Minute perforations of the ducts may close readily after the escape of some bile. The low pressure of bile secretion and the natural tendency for this duct to close after incision, if there exists no

obstruction to bile flow into the intestine, leaves little room for argument that an injury to the common duct, or even the gall-bladder, may heal rapidly and subsequently leave little trace of its existence.

Thus we have been led to assume that in those instances in which bile peritonitis occurs there must have been, at one time or other, an opening having a direct connection with the biliary passages. It is not necessary for the bile to be infected in order to cause bile peritonitis. We can produce bile peritonitis in the dog, with death within twenty-four hours, after the injection of sterile whole gall-bladder bile. In those cases in which one encounters considerable amounts of bile-stained fluid in the peritoneal cavity, resembling bile grossly, but in whom there exists no acute symptoms, so far as the fluid is concerned, and the findings at operation disclose no evidence of peritoneal reaction, such as is seen in true bile peritonitis, we must assume that the toxic factor of the bile is either absent or present in amounts which can produce no symptoms.

Obstruction of the common duct results in portal stasis. There is abundant evidence that in the laboratory animal this leads to an attempt at collateral circulation. If the collateral circulation is not efficient, ascites will result. It is our belief that the ascites which occurs during ductal obstruction is bile-stained as a result of general icterus and the bile salts present come from the blood bile salts rather than from filtration through the extrahepatic ductal walls. The recent investigations of Dragstedt and Spurrier,[22] Greene, Aldrich, and Rowntree[23] and Schalscha and Lande[24] would tend to confirm this hypothesis. Since the blood bile salts decrease early in obstructive jaundice and the biliary ascitic accumulations make their appearance later, we should expect a bile salt content comparable to that found in the blood at the time.

### SUMMARY

1. An attempt has been made to differentiate those cases in which bile causes a reactive inflammation of the peritoneum and those in which a large peritoneal accumulation of bile-stained fluid is apparently innocuous.

2. The amount of bile salts found in the bilious ascitic fluid in four instances was insufficient to have produced any toxic symptoms.

3. It is inconceivable that such a low concentration of bile salts could be found if the bile-stained fluid were the result of filtration through the walls of the extrahepatic bile ducts.

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DISCUSSION.—DR. GEORGE P. MULLER said that many years ago he operated upon a young boy who had suffered perforation of the gall-bladder twenty-four hours previously, from a gunshot wound, the bullet having cut a small furrow in the liver as well as nicking the gall-bladder. He suffered from symptoms of peritonitis and when opened, the abdomen was found to contain a good deal of bile-stained fluid. The rent in the gall-bladder was sutured and he made an uninterrupted recovery, being entirely free from trouble with his biliary apparatus at the present time, nineteen years later.

A second patient was operated upon elsewhere in October, 1928, and a cholecystectomy performed. The drain was removed in four days, but the patient returned after discharge complaining of abdominal distention and a paracentesis removed several quarts of bile-stained ascitic fluid. This was repeated in December and the patient again submitted to operation, at which time nothing was found except some bile with a good many adhesions. This patient was referred to the speaker on December 31 with a biliary fistula, but a few days later this stopped discharging and he made an uninterrupted recovery with rapid gain in weight and strength. Evidently at the first operation the stump of the cystic duct leaked and the unchanged bile slowly flooded the peritoneal cavity, giving rise to no symptoms except the peritoneal reaction to exudate. Contrary to the first case, there was no admixture here of blood from

the liver or of other elements from the wounds which might have activated the bile into an irritating substance.

In a third case the patient was suffering from cirrhosis of alcoholic and syphilitic origin, in which ascites and jaundice were the prominent symptoms. Here the bile-stained ascitic fluid was simply the bile-stained serum which exuded from the blood. In a fourth patient operated upon for a leak from the cystic duct, the external drainage failed to work and the bile flooded the abdominal cavity, carrying infection and causing fatal peritonitis.

If one studies the sequence of events in these four cases it is apparent that the action of the bile in the peritoneal cavity depends upon the bacterial contents or its power of chemical irritation. Certainly, bilious ascitis and cirrhosis is an entirely different proposition from a leaking cystic duct stump.

# SAFETY FACTORS IN MESENTERIC LIGATIONS *

## By Norman S. Rothschild, M.D.

### OF PHILADELPHIA, PA.

THE surgeon is often confronted at the operating table with the problem of the viability of the intestine after damage to its circulation in such clinical cases as laceration of the mesentery, mesenteric thrombosis, and strangulated hernia. In lacerations of the mesentery, which are usually accompanied by severe hæmorrhage, one wishes to do the least possible surgical procedure— that is, ligation of the bleeding points and closing of the wound of the mesentery. Radical procedures such as resection of the bowel increase the danger to the patient's life. Recovery from wounds of the mesentery after mere ligation of the bleeding vessels has been reported by Bost.[1] In three cases occurring on the service of Dr. John H. Jopson, although death eventually resulted from complications, autopsy revealed a normal intestine at the site of the injury.

Ross [2] and Klein [3] have reported cases of mesenteric thrombosis which have recovered without surgical interference other than simple laparotomy. In incarcerated hernia where the intestine is somewhat œdematous and doubt may exist as to the competence of the circulation, the bowel is replaced with the hope that the circulation will be reëstablished or a collateral circulation will form and so maintain the viability of the gut. Experience has taught us that this conservative measure is justified.

Anatomical studies of Dwight,[4] Mall,[5] and Eisberg [6] of the arterial supply to the intestine and, especially, Eisberg's study of the arterial supply to the intestinal coats, have given us a clear understanding of the vascular supply of this structure. Eisberg observed that "the blood supply consists of vasa recta arising from the last series of mesenteric arcades and passing directly to the intestine. These vessels generally alternate, one passing in front of, the other behind, the intestine. The vasa recta in passing between the serosa and the muscularis, give off numerous lateral offshoots which unite with similar branches from adjacent arteries. They pierce the muscle coat in the mesenteric quarters. They branch out in tree-like fashion as they approach the anterior mesenteric border and anastomose freely with the similar branches of the arteries of the opposite side. Numerous branches are given off from vasa recta at right angles to the vertical axis of the gut. These branches in turn divide and inosculate with similar branches above and below, as well as laterally, in the submucosa and mucosa. From the plexuses in the latter situation, arteries also arise from the terminal arcades and directly from the vasa

recta before the latter reach the muscularis." He believes that there is a well-defined mesenteric border arterial anastomosis in addition to the vasa recta.

Monks [7] has drawn attention in his exhaustive study of the mesenteric vessels, to the variations of arcade of the mesenteric vessels to the different portions of gut. He has suggested that a segment may be localized from a study of the vascularization. In the duodenum there is an occasional arcade; these arcades increase in number in the jejunum until a plexus formation is found in the terminal ileum.

In the intestine of the dog the blood supply is considerably different. Com-
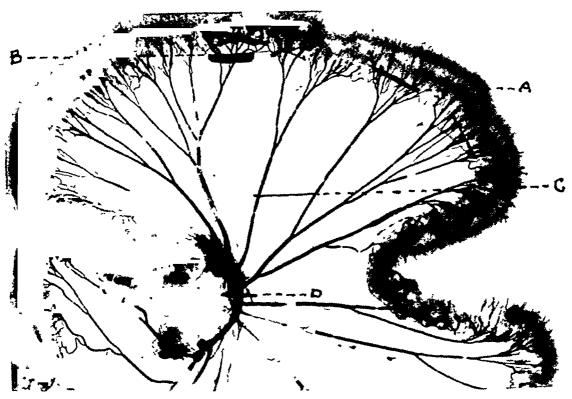


Fig. 1.—Section of intestine of dog with injection of the arteries with oxychloride of bismuth. *A, B, C, D* show the points of severance of the blood vessels. This specimen does not show the arcades, although that was one of the points at which severance was made.

ing off from the mesenteric artery we, as a rule, have numerous branches which at times form one, but rarely more than two, arcades, from which the vasa recta arise. *In the majority of instances there is a distinct marginal artery running along the mesenteric attachment to the intestine. This vessel varies in size and at times is so small as to be hardly recognizable.*

From an anatomical study one would expect a greater margin of safety in the human because of the extensive vascular plexus formation in the mesentery. (Figs. 1 and 2.) Our experiments were performed upon dogs under amytal anæsthesia (fifty milligrams per kilo), using aseptic precautions. In each instance the vessels, veins and arteries were severed between ligatures, and the opening thus formed was closed. In one case the site of the opening was covered with a portion of omentum. Several conditions were noted constantly. After severing of the vessels, that portion of the intestine supplied by the severed vessels contracted and became purple. Mall [5] made the same

observation with the exception that the intestine became ischæmic. It was also noted by me that the pulsation of all vessels distal to the ligation ceased. Severance of the vessels was performed at five points: (1) Along the mesenteric attachment; (2) through the vasa recta; (3) through the arcade; (4) through the main branches; and (5) through the mesenteric artery. Several of the above series were carried on in the same dog.

*Series A.* Severing of the mesentery along its attachment to the small intestine. Dog No. 1.—Severance of the mesentery for two inches along its attachment; died six days later with gangrene of the intestine.
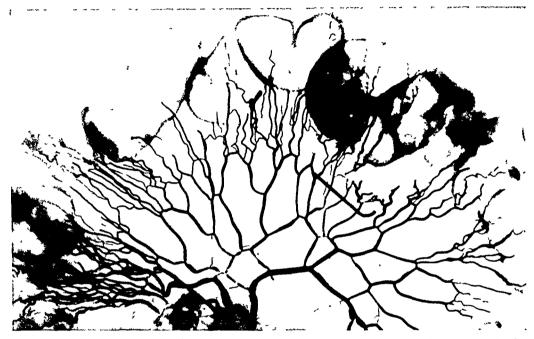


FIG 2.—Injection of the superior mesenteric artery of the human with oxychloride of bismuth of a portion of small intestine twelve inches from the duodenal jejunal junction. One notes the first, second, and third arcades of this vessel before the vasa recta are given off point of ligation.

Dog No. 2.—Severance of the mesentery for a distance of three inches along its attachment; death twenty-five days later; normal intestine found at autopsy.

*Series B.* Dog No. 3.—Severance distal to the first arcade; portion of omentum placed at site of severance. Autopsy five months and twelve days after operation revealed a normal intestine and numerous adhesions. These vessels were injected with iodized oil and X-rayed. This (Fig. 3) demonstrated that the original vessels distal to the point of ligation contained the iodized oil and that the circulation had been reestablished through the same vessels. On sectioning the omental graft, we could see the vessels containing iodized oil.

Dog No. 4.—Resection in front of the first arcade for a distance of six inches. Autopsy five months later revealed a normal intestine with numerous adhesions.

*Series C.* Dog No. 5.—Severance of first arcade supplying five inches of intestine. Autopsy four months and four days after operation showed normal intestine with adhesions.

Dog No. 6.—Severance of first arcade supplying five inches of the intestine. Autopsy seven months and ten days later revealed a normal intestine.

*Series D.* Dog. No. 7.—Severance above the root obstructing five inches of blood supply. Autopsy four months later showed normal intestine. Figure 4 shows an X-ray of this intestine after the vessels had been injected with a solution of oxychloride of

bismuth. Here we find that the marginal artery of the segment adjacent to the ligated portion is well developed, and that there are a few small arteries appearing at the site of ligation.



Fig. 3 Section of intestine found at autopsy of dog five months and twelve days after operation. Vessels were injected with iodized oil. Picture shows the reëstablishment of the circulation through the same vessels.

*Series E.* Dog No. 8.—Severance at the root, four to five inches of intestine involved; died three days later. Autopsy showed gangrene of intestine.

Dog No. 9.—Severance at the root, supplying six inches of intestine; died two days later, showing gangrene of the intestine.

Dog No. 10.—Severance at the root, supplying five inches of intestine; died five days later; gangrene of the intestine.

In the large intestine, there is a distinct marginal artery. It was our desire to resect the mesentery, leaving the marginal artery attached.

*Series F.* Dog No. 11.—Severance of the meso of the large intestine, distance of two inches. Autopsy three months later showed a normal large intestine.

Dog No. 12.—Severance of the meso of large intestine for a distance of five inches, leaving the marginal artery intact. Autopsy five months later showed normal intestine with adhesions.

From the foregoing experiments one can readily see that severance of the blood supply of the intestine between the mesentric attachment and



Fig 4.—Vessels of the dog's intestine after injection with a solution of oxychloride of bismuth. These vessels were severed at the root. Autopsy four months later. The reëstablishment of the circulation in this specimen was by means of the marginal arteries. Severance indicated by arrow.

the roots offers a great margin of safety, none of the dogs having died from such operative procedure. Involvement of the superior mesenteric artery, *per se,* produced gangrene in each instance. Severance of the mesentery from its attachment to the intestine produced gangrene in but one of the two cases.

The question naturally arises, by what means is the circulation reëstablished? In Figure 3 we have shown by means of the X-ray picture that the circulation has been reëstablished through an omental graft. Thus a communication was afforded between the intact blood supply and the original vessels which had been severed. In Figure 4 we have shown that a collateral circulation was established by the blood vessels adjacent to the severed vessels and that the collateral circulation was established through the marginal artery.

Numerous adhesions were found in all the cases. Some of these adhesions were found at the site of the severance while others were found along the intestinal wall. They were as a rule very filmy in character and grossly did

not show blood vessels of any considerable size. Eisberg[8] believes that the development of adhesions between loops of gut and the omentum are beneficial to the recovery of the affected gut. He also states that there is no evidence of the formation of new blood vessels through these adhesions. I am fully in accord with the first statement. As to the latter one, I feel sure that microscopic sections of the omentum at the site of adhesion would show vas-
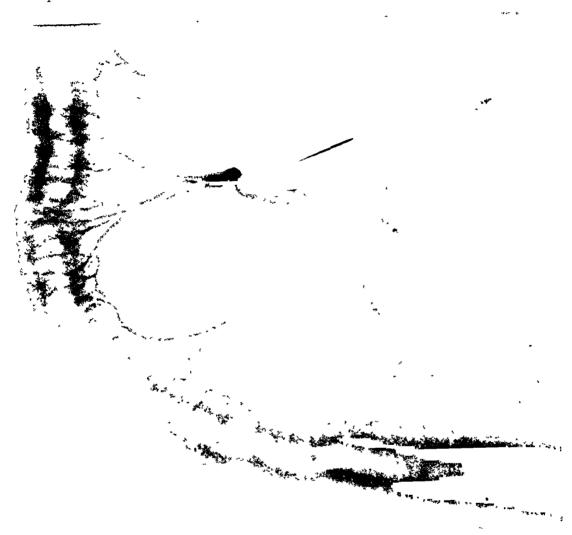


Fig. 5.—Vessels of the dog's intestine injected with iodized oil. This shows marginal artery conveying material to the part supplied by the separate vessels. Severance indicated by arrow.

cularization since Bothe[9] has demonstrated vascularization of even free grafts in a very short time after transplantation. Lanz,[10] Scudder,[11] and Wilkie[12] wrapped omentum around portions of the intestine from which the blood supply had been ligated. Wilkie found intestine intact over three and one-half centimetres long which had had its blood supply ligated. However, it was of no avail over larger areas.

## CONCLUSIONS

1. Interference with the circulation of the small intestine between the mesenteric attachment and the superior mesenteric artery is not usually accompanied by gangrene of the intestine. Interference with the superior mesenteric artery results in gangrene of the bowel. Detachment of the mesentery from

the intestine may not result in gangrene of the bowel. Severance of the mesentery of the large bowel, permitting the marginal artery to be left intact, does not interfere with the viability of the large intestine.

2. The reëstablishment of the circulation in the dog by means of the marginal artery of the segment and by means of formation of new vessels communicating with the vessels severed has been demonstrated. The adhesions in all probability do not play an important part in this. Adhesions of the omentum to the intestine may play a part in the vascularization of small areas of devitalized gut.

3. The degree of safety is far greater in man than in the animal.

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DISCUSSION: DR. JOHN H. JOPSON said that this paper which Doctor Rothschild has read opens up the field for a good deal of thought and discussion in connection with accidental and purposeful lesions following operations on the intestine or injuries to its blood supply. Some of his observations offer an explanation for what we have for a long while known clinically. One of the earliest lessons in the treatment of strangulated hernia is that there is a point in the progress of strangulation where we know that gangrene of the bowel will occur if not resected, and there is another group in which we are reasonably sure the viability has been preserved; and then, a large middle group in which experience many years ago taught us that return of the bowel is usually followed by recovery. The speaker recalled hearing Doctors Wharton and Deaver tell about their own experiences when young operators and the lessons they learned from the teaching of D. Hayes Agnew, who, when watching operations of this type and asked for advice, advised them the bowel be put back; the patients got well. The experience of most surgeons has been that many of the cases which looked doubtful, but in which the bowel was returned, did preserve their viability.

Doctor Rothschild's experiments explain why these cases did not go on to gangrene and how the circulation was reëstablished, by one or the other means which he has demonstrated experimentally. He mentioned the cases of

mesenteric thrombosis reported by Ross and others in which nothing was done but a simple laparotomy.

Doctor Jopson had one such case in which he found extensive mesenteric thrombosis, in which the bowel was returned and nothing further done, and the patient recovered. Doctor Deaver has also had such a case. This problem has been brought home to all of us by operations on the large intestine and especially operations for carcinoma of the rectum in two stages. Doctor Rothschild and the speaker have had unfortunate experiences with ligations of the inferior mesentery artery above the point where it should have been. In fat subjects it is sometimes hard to define just where the line of safety is and they have had some patients go to gangrene. The suggestion of the interposition of a mesenteric graft, or use of it as a covering of the bowel, seems a distinct contribution. The percentage of cases in which it may be used is small, and although we must not apply his conclusions too radically (remembering that the vascularity in dogs is different from that in humans), it is to be hoped at the same time that this contribution will in the future offer a means of overcoming or getting around this question of gangrene in small percentage of doubtful cases.

# THE FATE OF THE FREE OMENTAL GRAFT IN ABDOMINAL SURGERY*

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These experiments were undertaken in an effort to ascertain the fate of the free omental graft used in abdominal surgery. Macroscopic observations and histologic studies were made of the changes which occurred in the grafts from three days to four and one-half months after transplantation. The normal omentum was also studied as a control of the histological changes which occurred following transplantation of small portions of it.

*Technic.*—The grafts were all severed completely from the free border of the greater omentum, bathed in normal salt solution, and sutured to various sites. Care was exercised in avoiding trauma to the grafts during operative procedure. Grafts of various sizes were used, the longest being eight inches, and the smallest a half inch. Both thick and thin grafts were used. All operations were performed upon dogs under aseptic conditions.

The operative procedures in which the transplants were utilized were as follows: (1) Covering the site of the excision of a supposed gastric ulcer. Fluoroscopic and X-ray studies were made before and after operation. (2) Over the closure of an artificially produced perforation of the small intestine; (3) over smooth peritoneum of the small intestine; (4) over areas of small intestine where the peritoneum had been denuded; (5) over the pylorus following a Rammstedt operation; and (6) over the site of a pyloromyomectomy. In this procedure a longitudinal incision about one inch long was made through the pyloric ring in the anterior surface of the duodenum and stomach down to the mucosa. One-half inch of the pyloric muscle was then excised. The resulting serosal defect was not sutured, but was covered over by a free transplant of omentum. Fluoroscopic and X-ray studies were made before and after operation. (7) To cover artificial serosal defects in the spleen and liver accompanied by severe hæmorrhage.

Early in the experiment, black silk was used for sutures, but it was found that too great inflammatory changes occurred around these sutures and plain catgut was substituted. In a few grafts, only a few sutures were used, permitting considerable raw edge to be free. In the remainder, the raw edges of the graft were carefully approximated to the underlying tissue by multiple sutures. The raw edge of the omentum from which the graft had been severed was not inverted in the early experiments. In subsequent operations great care was exercised to cover this raw edge with normal omental tissue. The anæsthesia

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used was sodium amytal. The dosage was fifty milligrams per kilo of body weight given intraperitoneally.

*Discussion.*—The physiological functions of the omentum are still obscure in certain aspects, although the work of Ranvier,[1] Marchand,[2] Rossle,[3] Seifert,[4] Vogt,[5] Portis,[6] Cunningham,[7] and many other investigators has given us a better understanding of its structure and functions.

Aristotle[8] believed the omentum was a fatty apron designed to protect the viscera from cold. Vesalius[9] thought it was a ligament of support for the transverse colon. Verhagen[10] considered it a device to protect the abdominal viscera from sudden jars and from sudden friction. Hansen[11] was of the opinion that it served to pull the stomach downward when that organ was full and thus facilitated the descent of the diaphragm in respiration.



Fig 1—Drawing of a graft over a pyloromyomectomy at two months. (*a*) Graft. (*b*) Long silk suture.

The knowledge derived with the development of abdominal surgery and from experimental studies made on the omentum has established a more scientific comprehension of the functions of this peculiar membrane. This tissue consists of loose, irregularly arranged connective tissue which contains a wide variety of cells. We now believe the functions of the omentum to be: (1) the playing of a very important part in the defense reactions in various pathological conditions within the abdomen; (2) the endowment with movements which are believed to be either "intelligent" or mechanical; (3) the encapsulation of necrotic tissue; (4) increasing the viability of partially devitalized bowel; and (5) usefulness as a graft—free or attached, to cover serosal defects.



Fig 2—Drawing of a graft over a pyloromyomectomy at four and one half months (*a*) Remaining silk sutures at periphery of graft (*b*) Grafted area.

The ability of the omentum to increase resistance to peritoneal infection is of the utmost importance in abdominal surgery. Experimental studies have shown this to be due to two characteristics of the omentum; namely, (1) the power of absorption, and (2) mobility. Maximow[12] has so clearly described this reaction that I quote his words. "In cases of inflammatory irritations of the peritoneum, the reactive phenomena develop with the greatest speed and manifest themselves with the greatest intensity in the omentum. If particulate matter of any kind, including bacteria, enters the peritoneal cavity, it is taken up and disposed of by the histiocytes of the

omentum. These elements seem also to take an active part in the elaboration of antibodies. The omentum contains many histiocytes. They are flat, angular or fusiform elements, which may be markedly stretched out and provided with long branched filiform processes. In the so-called milky spots and along the larger blood vessels, the histiocytes constitute the majority of the elements of the tissue. The mobilized histiocytes (macrophages) of the omentum pass in large numbers into the peritoneal exudate. In inflammatory processes, their number in the exudate increases enormously."

Numerous studies have been conducted to determine the absorptive powers of the omentum and many substances have been used in these studies, *i.e.*, physiological salt solution, india ink, chinese carbon, carmine, defibrinated chicken blood, and bacteria. Wilkie[13] found that



Fig 3.—Microphotograph of free transplant seventy-two hours after transplantation

cats with and without omenta absorbed salt solution in the proportion of three to two, respectively. When sterilized powdered charcoal was used he found at postmortem, forty-eight hours after introduction, that all abdominal viscera were irregularly coated with the carbon particles in the cats in which the omentum had previously been removed, whereas in the animals with the omentum intact, the whole of the charcoal was taken up by the omentum and the other abdominal viscera
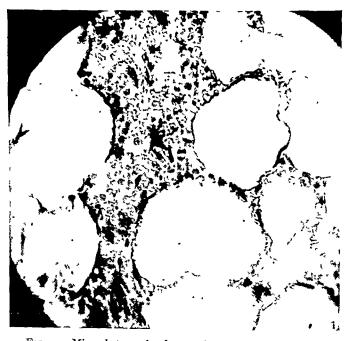


Fig 4.—Microphotograph of transplant four days after transplantation, showing beginning endotheliazation of newly formed blood space.
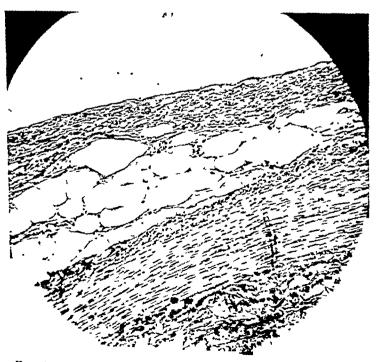
had a normal glistening appearance. He then injected suspensions of staphylococcus aureus into the peritoneal cavity of cats with and without omenta. A few hours after injection he aspirated fluid from the peritoneal cavities and found many cocci in the free fluid and in the leucocytes in those without omenta and few cocci in those with omenta. He later killed a cat with the omentum intact and found this organ densely covered with cocci, many of which were being phagocyted by the mobilized histiocytes (macrophages) of the omentum. The recovery was much more rapid in animals with than without omenta, illustrating the protective action of this structure. Crouse[14] believes the phagocytic protection of the abdominal cavity is



FIG. 5.—Microphotograph of thin graft fourteen days after transplantation.

mainly due to the ability of the omentum to increase its lymphatic and hæmic activities. Frequently, the omentum is found wrapped around the site of peritoneal inflammation, which may result in localization of the disease. Its function in this particular is most valuable and it has therefore aptly been termed the "policeman of the abdominal cavity".

Rutherford Morrison,[15] Milian,[16] and others state that the omentum is capable of intelligent movements. This belief is based on the fact that the omentum is so frequently found at the site of the source of an abdominal infection. After moving to the area, the omentum



FIG 6.—Microphotograph of thick transplant fourteen days after transplantation.

walls off the infection and is responsible for the localization of many infectious, as well as necrotic, processes, thereby preventing many complications from the development of a generalized peritonitis or toxæmia. The frequency with which this is found has led these investigators to believe the movements are due to an intelligence possessed by the omentum.

Neusner[17] was the first to regard the movements of the omentum as purely mechanical. The inflamed area is less movable than other parts of the abdominal cavity and, because of the respiratory and peristaltic movements, the free border of the omentum settles at the "quiet spot". There, as the result of inflammatory action, an increased



FIG. 7.—Microphotograph of edge of transplant fourteen days after transplantation.

formation of lymph and a roughening of the peritoneal surface has taken place. In a short time, the omentum becomes adherent and encapsulation results. A protective, fibrinous exudate appears which seals off the attachment of the omentum to the inflamed area. At one time, chemiotaxis was thought to play a part in the movements of the omentum to the inflamed area. This has only been a hypothesis, however, and there has been no scientific evidence forthcoming which would lend weight to this view.

In this experimental study, the omentum became adherent to the in-
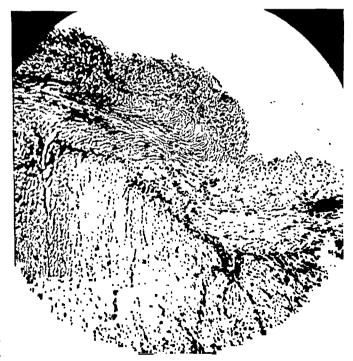


FIG. 8.—Microphotograph of thin transplant two months after transplantation.

testine twice, producing obstruction. From this it would appear that the omentum is not endowed with "intelligence" which conducts these movements, but, on the other hand, it adds strength to the belief that the motility of the omentum is purely mechanical.

The ability of the omentum to encapsulate necrotic tissue was first demonstrated by De Rienzi and Boeri[18] in 1903. They ligated the pedicle of the spleen, and, to their surprise, the animal lived. Some weeks later at autopsy, they found the spleen to be a small fibrous nodule encapsulated in the omentum. Similar experiments were then performed on dogs in which the omentum had been removed, and all the animals
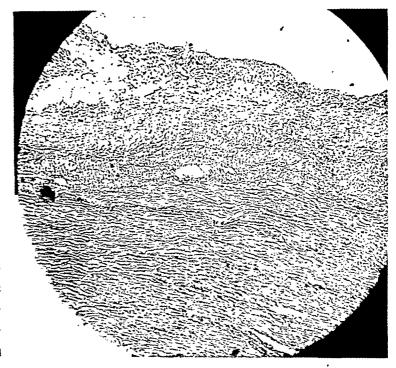


FIG. 9.—Microphotograph of thin transplant four and one-half months after transplantation.

died from toxæmia from absorption of products of decomposition from the spleen. This work has been confirmed by Pirone[19] and Wilkie.[13] These results suggested the wrapping of omentum around a strangulated portion of intestine, the viability of which was doubtful, or when the patient's condition
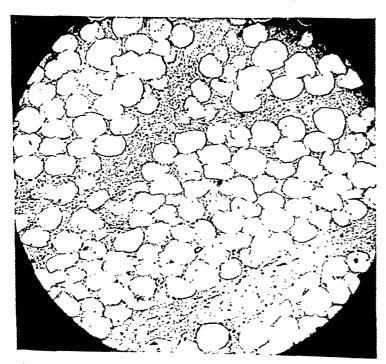


FIG. 10.—Microphotograph of thick transplant four and one-half months after transplantation.

did not warrant resection. Only recently, Bost[20] has described a similar use of the omentum with successful results. Lanz,[21] Scudder,[22] and Wilkie[13] wrapped omentum around portions of the intestine from which the blood supply had been ligated. Wilkie[13] found the intestine intact in an area three and one-half centimetres long which had had its blood supply shut off, but it was of no avail in larger areas. He concluded that wrapping with omentum was of value in partially

devitalized intestine in that it prevented perforation and peritonitis when the area was small.

The omental grafts employed extensively in abdominal surgery to cover serosal defects are of two types: (1) The free transplant; (2) the attached. The attached grafts are used less frequently as the indications are fewer in number and the possibility of internal herniation or adhesions with subsequent obstruction are too great, to say nothing of the traction on the stomach or transverse colon with resulting torsion of these organs. The attached grafts, however, are preferable in the presence of infection. Experimental studies, particularly those of Peet and Finton[23] and Davis,[24]



FIG. 11.—Microphotograph of normal omentum with sparse vascularization.

have clearly shown that free transplantation of the omentum is not successful when infection is present. Senn,[25] in 1888, was the first to advocate the use of the free omental graft. He found such portions of the omentum adhered firmly to the surface to which they were applied, became vascularized, and he observed no untoward results from such grafting.

On the contrary, after a careful study, Rubin[26] concluded that detached omentum becomes necrotic and is useless. C. H. Mayo[27] states that free grafting of the omentum is a temporary patch which soon undergoes necrosis and becomes absorbed after serving its purpose. Peet and Finton,[23] in a
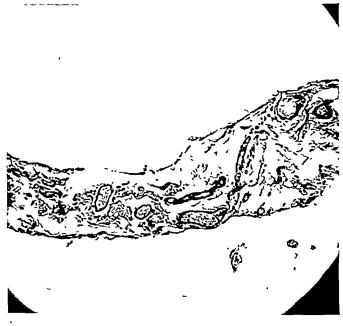


FIG 12.—Microphotograph of normal omentum with rich vascularization.

histological study of omental grafts, concluded in the absence of infection, the thin graft survives at least six months practically unchanged. Brocq, Ducastaing, and Reilly [28] were the first to establish the fact that the free transplants were not only successful, but, in addition, the surface endothelium of the transplanted omentum persists.

Springer [29] and Wilkie [13] believe it to be a satisfactory procedure, but contend that this practice has unavoidable disadvantages in that it almost inevitably leads to extensive peritoneal adhesions. Bennett,[30] in 1896, and Braun,[31] in 1897, reported successful results obtained from covering perforated gastric ulcers with omental grafts. Tietze,[32] Enderlen.[33] Reering,[34] and E. J. Senn,[35] used the omen-



FIG. 13.—Microphotograph of two portions of same graft, illustrating different degrees of cellular changes at three weeks. See Fig. 14.

tum on intestinal work on dogs and proved its ability to seal, occlude and serve as a vehicle for mucous membrane development over the gastric defect. Later, Hesse [38] recommended its use to strengthen sutures in operations on the stomach, colon, and urinary bladder. Brocq, Ducastaing, and Reilly [28] recommend the utilization of free transplants to peritonealize the denuded area following resection of kinks or adhesions at the ileocolic junction.
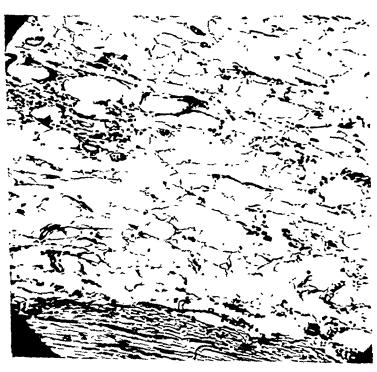
In addition to these clinical observations and experimental studies, a large number of conditions have been reported in which free omental grafts have been used suc-



FIG. 14.—See Fig. 13.

cessfully in abdominal surgery; *i.e.*, to cover incomplete peritonealization of the false pelvis in pelvic surgery, the burying of the stump of cystic duct or Fallopian tube, covering the duodenal stump after gastric resection, reënforcement of the peritoneum in threatened perforations.
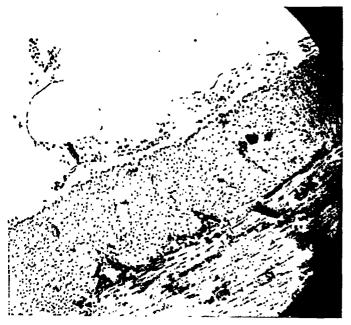


FIG. 15.—Microphotograph of unsuccessful transplant on smooth peritoneum two months after transplantation.

Loewry,[36] in 1900, was the first to describe the hæmostatic action of the omentum. He used it successfully to control hæmorrhage from the liver and found it became rapidly attached to the liver and soon became difficult to detach. L. Stucky[37] reported a case of profuse hæmorrhage from the liver bed following cholecystectomy. The only method he could find effective to control hæmorrhage was the use of a free omental graft. The patient died three days after operation, and at post-mortem examination the graft was firmly adhered to the liver and there was no free blood in the abdomen.

Hesse[38] made similar observations and demonstrated capillary formation in the transplanted omentum in three to four days. He cited eighty-nine cases of traumatism of the liver that came under his observation in seventeen years. Of seventy-nine cases treated by suture, cauterization, and tamponade, 39.3 per cent. died. The last ten cases in this series he treated with free omental transplantation without a single death.

*Results.*—The earliest macroscopic observations in these experiments were made seventy-two hours



FIG. 16.—Microphotograph of transplant on smooth peritoneum two weeks after transplantation, demonstrating necrosis.

after transplantation. The raw edge at the junction of the graft with the underlying tissue was covered with a plastic exudate. Traction on the graft at this time showed it to be adherent, but it could easily be detached by force. When the graft was lifted bleeding occurred from the under surface. At the end of two weeks the surface of the grafts was smooth and they could only be removed by forceful traction.

No gross changes were noted in the appearance of the grafts from two weeks to two months after transplantation. At two months, however, the grafts appeared as if partial absorption had occurred, though they were still in evidence and were definitely elevated from the surrounding surface as is represented in Figure 1.
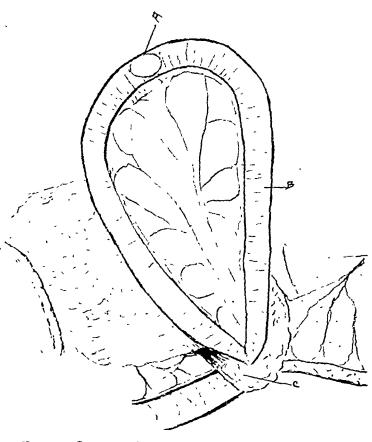


Fig. 17.—Diagram of a raw edge of omentum from which graft was taken, becoming adherent to another portion of itself, producing intestinal obstruction. A.—Free graft. B.—Small intestine. C.—Adherent greater omentum producing intestinal obstruction.
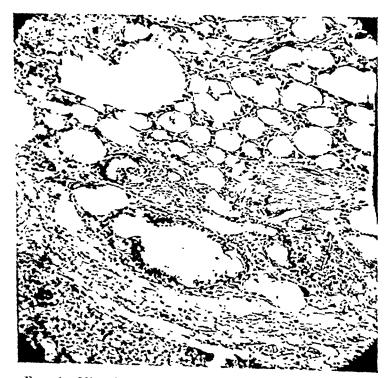


Fig. 18.—Microphotograph of transplant in wound of liver thirteen days after transplantation.

At four and one-half months the thin graft was entirely absorbed and it was not possible to distinguish the outline of the area over which it had been sutured. The fat graft was easily identified at this time and apparently very little if any absorption had occurred. Figure 2 is a drawing from a specimen removed at autopsy four and one-half months after a thin graft had been sutured over the serosal defect of a pyloromyomectomy. The black

silk sutures which were used were the only means of identification of the outline of the graft.

*Histological Findings.*—Chronological histological studies revealed the actual cellular changes which occurred in the transplanted omentum. The earliest section was that of a graft three days old which was entirely adherent to the bowel wall at that time. Many young blood spaces and a few young fibroblasts were scattered throughout the graft. At this early date the endothelial layer of the graft proximal to the bowel wall was beginning to undergo degeneration. The junction of the edge of the graft with the bowel wall was smooth, though endothelium had not grown over it. (Fig. 3.) At the end of four days there was evidence of beginning endothelialization of the newly-formed blood spaces. (Fig. 4.) At fourteen days the graft had the appearance of young fibrolipoid tissue. Scattered throughout were a number of vascular spaces of various sizes and ages, manifested by the presence and absence of endothelial lining. In some areas the fatty content of the fat cells was no longer evident, and there was a marked increase in fibroblastic and angioblastic elements, more pronounced on the proximal surface. The endothelial cells on the under surface of the graft had entirely disappeared. (Fig. 5.) The number of remaining fat cells varied. In one graft only a few fat cells were found at the periphery. In others, they were still quite abundant throughout. (Fig. 6.) The endothelial covering of the graft had joined that of the recipient organ and was continuous with it. (Fig. 7.) At twenty-one days in thin grafts the fat tissue had almost entirely been replaced by dense angioblastic and fibroblastic proliferation. At this time the angioblasts and fibroblasts could be seen infiltrating into the underlying tissue. (Fig. 13.) In the fat grafts these changes occurred in the proximal portion, but very little change was found in the peripheral fat cells.

At two months vascularization was mature and the fibroblastic proliferation was far advanced. The graft appeared as a layer of fibrous tissue which had grown over the surface of the underlying tissue. (Fig. 8.) Numerous fat cells were still visible in the fat transplants.

At four and one-half months there was considerable difference between the microscopical picture of the thick and thin grafts. In the thin grafts no fat cells were visible, the fibroblasts had undergone marked absorption and the vascularization was greatly diminished. The endothelial covering was complete. (Fig. 9.) The thick graft still possessed the fibroblastic and angioblastic tissue unchanged and fat cells were present in abundance. (Fig. 10.)

The only noteworthy finding in the histological study of the normal omentum was the difference in the degree of vascularization. Some sections contained numerous blood vessels, others relatively few. The extremes in vascularization are represented by Figures 11 and 12. This observation was thought to be of significance as indicated by the cellular changes found following transplantation.

Several factors were responsible for variation in the histological findings just described. Cellular changes in the grafts varied in dogs examined at similar periods after transplantation in which the same types of grafts were

used under similar conditions. As the changes were not uniform in dogs, it is reasonable to deduce similar circumstances occur in the human. In fact, different parts of the same graft showed variations in angioblastic and fibroblastic proliferation. (Figs. 13 and 14.) This was thought to be due to the distribution of the blood vessels in the graft employed, though the degree of vascularization of the grafts used was not noted at the time of transplantation. As measured by cellular changes, the thin graft is preferable. These observations lead to the deduction that the ideal graft should be thin and well vascularized.

The grafts transplanted upon the smooth peritoneum united less satisfactorily. The only unsuccessful transplant was in this group. In this instance at post-mortem examination the graft was entirely disappeared and the black silk used for sutures was found in the adjacent mesentery of the intestine. (Fig. 15.) Microscopically, the incomplete union was apparent, fewer cellular changes were noted in their structure and several grafts showed necrotic changes. (Fig. 16.)

The development of post-operative adhesions has been the objection some surgeons have made to the use of omental grafts in abdominal surgery. Early in this study, the adhesions found at post-mortem examination were of three types: (1) In large grafts the raw edges of the omentum on adjacent loops of bowel would become adherent, producing angulation with resulting obstruction and death; (2) the greater omentum would become adherent to the raw edge of the graft (apparently harmless adhesions); (3) the free border of the greater omentum from which the graft had been severed would become adherent to another portion of itself or other abdominal viscera. The technic was modified in an effort to overcome these complications. Smaller grafts were employed and results showed that the raw edge of a graft larger than five centimetres, when transplanted to the small intestine, became adherent to another portion of itself with resulting angulation of the bowel and its sequelae. Subsequent formation of adhesions to the graft was largely, though not entirely, overcome by careful suturing of the graft to the viscus. This procedure decreased the amount of raw edge exposed and thereby decreased the possible formation of adhesions.

When only a few sutures were used to hold the graft in place, adhesions were invariably found at autopsy. Though this type of adhesion is apparently harmless, care should be taken to minimize its formation. Peet and Finton [23] suggested inversion of the raw edge before suturing the graft. This procedure was not employed as it is more time-consuming and necessitates greater trauma to the graft.

The raw edge on the free border of the omentum was carefully covered in the later experiments. Two fatalities demonstrated the necessity of this procedure. In both instances there were no adhesions to the grafted areas, but the raw edge on the free border of the omentum had wrapped itself around a piece of small intestine and become adherent. Fibrosis with contraction occurred producing obstruction with subsequent death. This is rep-

resented diagrammatically by Figure 17. The cut edge was ligated with black silk and the silk ligature was found at the site of the adhesions, proving that the raw edge from which the graft was removed had become adherent and was responsible for the obstruction. This is by no means a new observation. Davis,[24] in 1917, in a report of an experimental study of omental grafts, suggested that the raw stump of the proximal portion of severed omentum must also be rolled back under normal tissue to avoid adhesions. These two fatalities made a profound impression as to the dangers of not covering the raw edges from which the graft is severed. This may be overcome by rolling back the raw stump under normal omental tissue as suggested by Davis, or by actual inversion between two layers of the omentum. This type of adhesions did not occur after the above precaution was adopted.

The hæmostatic action of the free omental graft was very clearly demonstrated. Stab wounds were made in the liver and spleen and pieces of spleen were actually gouged out. In these experiments the hæmorrhage was profuse and beyond control by pressure. Free grafts were sutured over the injured areas and the bleeding was controlled almost instantaneously. Although there was considerable hæmorrhage beneath the grafts, they were all completely united to the underlying tissue and there was definite angioblastic and fibroblastic proliferation within the grafts. Figure 18 is a microphotograph of a transplant covering a wound in the liver thirteen days after transplantation. The microscopical findings were the same when the transplant covered a defect in the spleen.

X-ray and fluoroscopic examinations were made upon the dogs before and after excision of a supposed gastric ulcer and pyloromyomectomy. The dogs were anæsthetized with sodium amytal for these studies. The anæsthetization diminished peristalsis so markedly that satisfactory deductions could not be made. However, at post-mortem examination there was no visible defect in the stomach or pylorus after these operative procedures. Upon opening the stomach, the mucosa had apparently grown over the site of the excision of an ulcer at three weeks, though it was greatly puckered at this point. Obstruction did not occur following pyloromyomectomy, the pylorus was patulous and there was no evidence of contracture.

### CONCLUSIONS

1. Thin omental grafts are preferable to thick grafts for free transplantation.

2. The ideal graft should be thin and well vascularized.

3. Care should be exercised to cover the raw edge on the free border of the omentum from which the graft is severed.

4. Free transplants should be carefully sutured to the underlying tissue.

5. Free omental grafts unite far more satisfactorily when the peritoneum has been denuded.

6. Union is complete and young blood spaces and fibroblasts are found in transplants seventy-two hours after transplantation.

7. Endothelialization of newly-formed blood spaces begins ninety-six hours after transplantation.

8. The surface endothelium persists and at two weeks is continuous with the endothelial covering of the recipient organ.

9. Angioblastic and fibroblastic proliferation is pronounced the first two months after transplantation. Subsequently, absorption occurs and there is almost complete absorption of the thin graft at four and one-half months.

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DISCUSSION: DR. JOHN SPEESE said that the results of these investigations have been particularly interesting and valuable as it has been possible to apply many of these principles in clinical work in which Doctor Bothe has been associated with him. In fact some of the problems worked out experimentally, such as the relative value of the large or small, the thin or the thick transplant, were suggested in the course of operations in certain types of cases in which omental transplants had been used.

During the past few years he had encountered numerous instances of ileocæcal obstruction, cases in which removal of the appendix had not been followed by success insofar as relief of symptoms was concerned. In these cases the terminal ileum is thickened, the opening into the cæcum is not demonstrated easily because of adhesions existing between the ileum and cæcum. If the ileum is released by careful dissection, the ileocæcal opening then becomes apparent. The resulting peritoneal defect has been covered with omental grafts after the manner described in Doctor Bothe's experimental work.

The results obtained in some of these patients has been gratifying, particularly when constipation has been a conspicuous symptom. It has seemed that narrowing of the ileocæcal opening by preventing the liquid content of the small bowel from gaining ready access to the cæcum has been more or less responsible for the development of constipation in certain cases.

In a few cases in which appendectomy, previously performed, had been followed by a continuation of symptoms such as pain and constipation, relief has been secured by the above described measure.

Doctor Bothe and the speaker have reported cases in which they have endeavored to relieve pylorospasm by partial pyloromyomectomy, and in these cases have covered the incision with an omental graft. They have hesi-

tated to do such a radical operation as recommended by Martin and Burden and have secured favorable results with relief of symptoms by partial division and resection of the muscle. In order to prevent adhesions they have covered the defect by an omental graft. The use of omental grafts has proven valuable also in controlling bleeding in the Rammstedt operation for pyloric stenosis in children. The application of a bit of omentum here held in place by a single suture has seemed to be more efficient than an attempt to ligate the small vessels.

Ligation of large areas of omentum may be followed by adhesion of the ligated stump to the intestine. The practice, therefore, of infolding the omental stump is to be endorsed and should be carried out in all such instances. In cases in which the omentum is wrapped around an inflamed appendix, after removal of the portion of the inflamed omentum, it is desirable, if feasible, to shorten the omentum by infolding in order to prevent its adherence to the ileum which has been found to be the cause of intestinal obstruction in several recent cases.

# THE SMALL DEEP GRAFT

## RELATIONSHIP TO THE TRUE REVERDIN GRAFT [*]

### By John Staige Davis, M.D.

#### OF BALTIMORE, MD.
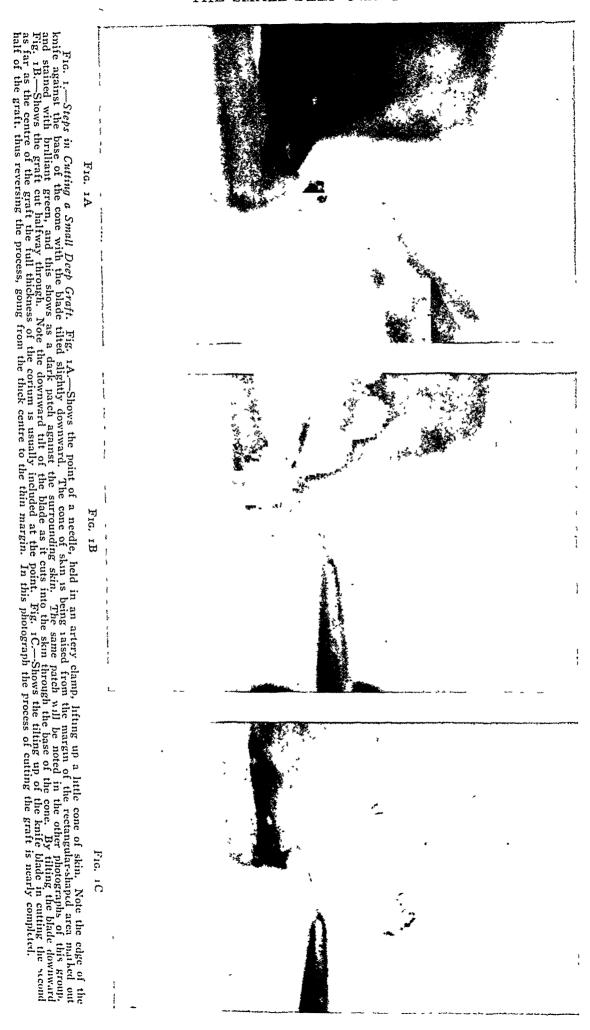
FROM THE SURGICAL DEPARTMENT OF THE JOHNS HOPKINS UNIVERSITY AND HOSPITAL

THE object of this paper is to trace the evolution and use of a type of small graft which contains more of the corium than the superficial graft developed by Reverdin and to inquire into its relationship to the true Reverdin graft. Incidentally, I hope to interest those of you who are unfamiliar with these grafts so that you may at least give them a trial, as I have found them most useful in solving both simple and complicated problems in wound healing. At the risk of repeating statements which I have made, I will again call attention to certain points.

Twenty years ago when making a study of the patients which had been skin grafted at the Johns Hopkins Hospital, I found that among the first five hundred and fifty cases there were notes in two instances on what were called Reverdin grafts. The patients on whom these grafts were tried were negroes and both the lesions were leg ulcers. In one case, the grafts were used after the partial take of a white Ollier-Thiersch graft, and in the other, as a fifth attempt after partial failures of auto and iso-Ollier-Thiersch grafts. In both instances, these small grafts took and permanent healing followed. It occurred to me that these grafts might well be used more frequently as they seemed to be successful in particularly resistant cases where larger grafts had failed. At that time I had never seen a Reverdin graft used either at the Johns Hopkins Hospital or at any other hospital which I had visited, as this type of graft had been almost completely superseded by larger Ollier-Thiersch grafts of the same thickness. So becoming interested, I began to look up literature on the subject and found it voluminous, especially in the early '70's.

The hastening of the healing of granulating wounds by the transplantation of small bits of epidermis was first demonstrated by J. L. Reverdin, a young Swiss intern in the Necker Hospital in Paris, in Guyon's service. His report was made to the Société Impériale de Chirurgie on December 8, 1869, where he showed a patient on whose thumb he had transplanted bits of epidermis. He described the original process as follows: "I raised with the point of a lancet two little flaps of epidermis from the right arm, taking care not to cut the dermis." These bits of epidermis planted on the granulating surface lived and grew and with the addition of others caused partial healing. This paper was discussed on December 15, 1869, but, with the exception of Guyon and Marc See, no one in France seemed to realize the importance of the discovery that bits of epidermis could be transplanted, and would live and proliferate. G. S. Pollock, of St. George's Hospital, London, hearing of Reverdin's

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[*] Read before the Southern Surgical Association, December 12, 1928.

FIG. 1A

FIG. 1B

FIG. 1C

FIG. 1.—*Steps in Cutting a Small Deep Graft.* Fig. 1A.—Shows the point of a needle, held in an artery clamp, lifting up a little cone of skin. Note the edge of the knife against the base of the cone with the blade tilted slightly downward. The cone of skin is being raised from the margin of the rectangular-shaped area marked out and stained with brilliant green, and this shows as a dark patch against the surrounding skin. The same patch will be noted in the other photographs of this group. Fig. 1B.—Shows the graft cut halfway through. Note the downward tilt of the blade as it cuts into the skin through the base of the cone. By tilting the blade downward as far as the centre of the graft the full thickness of the corium is usually included at the point. Fig. 1C.—Shows the tilting up of the knife blade in cutting the second half of the graft, thus reversing the process, going from the thick centre to the thin margin. In this photograph the process of cutting the graft is nearly completed.

work, first used his type of graft in May, 1870, with great success and the method was enthusiastically taken up by various surgeons in England, from whence it spread to the United States and other countries.

In Reverdin's original operation, as noted above, he obtained his grafts from the arm, but later he utilized the inner surface of the leg in the following way: He held the skin tense over the flat surface of the tibia and introduced the point of a rather large venesection (double edged) lancet parallel to the bone, and to the depth of 0.5 millimetre. The lancet was then pushed forward so that the point would emerge two or three millimetres farther on, the small piece of epidermis being cut loose by the edges of the lancet. He adds that the little wound is the seat of a fine sanguineous dew.

When a small deep graft is cut, unless the anæsthesia has been induced by infiltration with novocain containing adrenalin, there is free bleeding from the wound from which each graft is taken, showing that



Fig 2 —*Method of Cutting a Reverdin Graft* The little cone of skin is raised by the needle just as if a Small Deep Graft were to be cut Note that the knife blade is held flat at the level through which the tip of the cone is to be cut across. In this way by cutting close to the needle the thinnest possible graft can be removed Compare the position of the knife and the level to be cut in Figs 1 and 2, and it will clearly show the difference between a true Reverdin and a small deep graft.

a much greater depth of skin is removed and this clearly indicates the difference in thickness between a true Reverdin graft and a small deep graft.

Grafts obtained by Reverdin's method are usually thought of as pure epidermic grafts, and in his articles, Reverdin always spoke of them as *"greffe epidermique,"* but in his exhaustive paper on the subject published in 1872 he says in part: "The title *'epidermic grafts'* is not perfectly correct, as the transplanted bit is composed of the whole epidermis and a very little of dermis."

In other words, Reverdin described the graft which is named for him as a pure epidermic graft, but later found that it consisted of the epidermis and a very thin layer of the corium. In short, it was the thinnest graft that he could cut. Little is found in the literature on Reverdin grafts after the '80's. until an excellent article by Ehrenfried and Cotton was published in 1909.

Experimenting with the Reverdin type of graft. I also found by microscopic examination that it was impossible to cut a pure epidermic graft, how-

ever thin the graft might seem to be, except possibly on the bottom of the foot where the epidermis is very thick. I noted that grafts which were deeper and contained more of the corium took as well and gave a more stable healing than when the thinner Reverdin grafts were used. In 1914, after five years of experimenting with different thicknesses of small grafts, I reported the results of this study, which was based on a large number of cases grafted with small thick grafts which will be described below, and I called these grafts "small deep grafts".* The grafts are somewhat larger
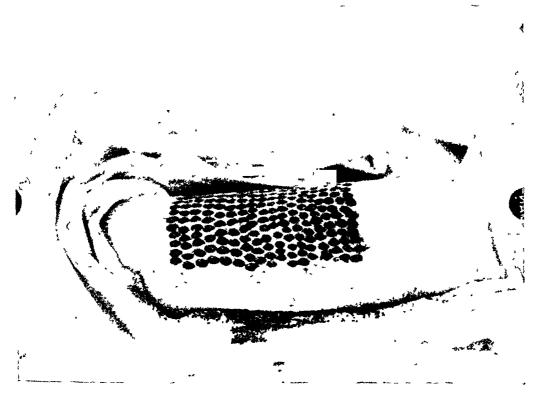


FIG. 3.—The area on the anterior surface of the thigh from which a considerable number of Small Deep Grafts have been cut  Photograph taken two days after operation. Note the rim of epithelium left between pits made by removal of the grafts. It can be seen that no material has been wasted in securing these grafts and that a large number of grafts may be obtained from a comparatively small area.

than Reverdin grafts and differ from them in that they include, in addition to the epidermis, practically the entire thickness of the corium, the thickest portion being the centre of the graft. The margins of the grafts are quite thin, but the thickness gradually increases so that at the centre the graft usually includes the full thickness of the corium. This has been verified many times by the microscope and also by the fact that the subcutaneous fat can be seen shining through the central portion of the little wounds from which the grafts are taken.

These grafts which differ in thickness from true Reverdin grafts practically as much as whole thickness grafts differ from Ollier-Thiersch grafts. should not be confused with thin Reverdin grafts and should certainly not be called Reverdin grafts.

* The work on this type of graft was largely done at the Union Memorial Hospital and, later, in the Out-Patient Department of the Johns Hopkins Hospital.

Since the publication of my paper in 1914 other reports have appeared on the same subject, and many of the authors have accepted the title "small deep grafts". Some writers, however, still do not appreciate the difference between the true Reverdin graft and the small deep graft. For example, Reverdin grafts have been described as minute plugs of full thickness skin, which is neither the description of a Reverdin graft nor of a small deep graft.



FIG. 4A.—Ten days after grafting an extensive granulating wound of the buttock and thigh with Small Deep Grafts. The lesion was of thirteen months' duration before the patient came under my care and followed a severe burn. Note the halo of new epithelium from the margins of the grafts. In many places the surface is already covered with epithelium by fusion of the new epithelial growth from the grafts and wound edges. The wound was completely healed within three weeks after grafting.

Another author describes small deep grafts in a well-illustrated article and calls them Reverdin-Halsted grafts, which title is hardly correct as the grafts described are not Reverdin grafts, and, furthermore, Doctor Halsted had nothing to do with the development of this type, as the method was completely worked out before his attention was drawn to it.

At one time, Reverdin grafts were obtained by pinching up a superficial bit of skin with forceps and cutting or pinching it off with scissors, and on account of the method the grafts were called "pinch grafts". One frequently hears the term used also for small deep grafts, but there is no excuse for using it any longer, either for Reverdin grafts or small deep grafts, as the use of forceps and scissors has long been abandoned by surgeons having any respect for tissues as they cause unnecessary trauma, both in lifting and cutting the graft, and thus violate one of the fundamental surgical principles.

In 1922, Dehelly read a paper entitled "La Greffe Cutanée de Davis" before the Society of Surgery of Paris. He followed quite closely the technic used by us, and gave the results of his experience with these grafts. Active discussion followed and among the points made the following may be interesting:

Paul Thiéry and A. Schwarz said, in part, that there was nothing new about this type of graft and that the method was ancient. They also said that the grafts were identical with Reverdin grafts. P. Sebileau and P. Duval said, in part, that these grafts were the same as the dermo-epidermic grafts

of Ollier. Cunéo said that the grafts described were neither the grafts of Reverdin, which are very small epidermic grafts, nor the grafts of Thiersch, which are dermo-epidermic grafts and are characterized by their thinness. Also that the results shown do not resemble in any way those following a Thiersch graft.

Savariaud and Mauclaire said, in part, that the grafts did not merit the name of whole thickness, but were simply dermo-epidermic grafts. In answer to some of these criticisms, I would say that apparently it was not clearly understood, by those discussing the paper, that the grafts did not include the full thickness of the skin at every portion, but only in the centre.

Reverdin's discovery, in 1869, that small bits of "epidermis" could be transplanted and would grow in a new field stimulated a great deal of investigation along these lines, and upon his work is based the entire structure of skin grafting as used today. As I have said before, it was while investigating and trying out his method that the thicker grafts which we call small deep grafts were experimented with, and proved



Fig. 4B.—The same area one year later. Note the soft pliable type of healing, which has remained stable now over a period of eleven years. Note the individual grafts, each of which can be seen as a patch of normal appearing skin which is soft to the touch.

so much easier to cut and gave so much more stable healing that it seemed best to use them. This method may have been used long before I began to work on it, as there is little that is really new when one goes back into the past. However, after a rather careful search, I am unable to find a report of this type of graft previous to my original paper.

Unquestionably small deep grafts are dermo-epidermic grafts, but I cannot agree that these grafts are made after the method of Ollier, my reason being the following quotation from Ollier's communication in 1872: "Instead of grafting small bits of epidermis two, three and four millimetres square as M. Reverdin does it, M. Ollier grafts large flaps of four, six, and eight centimetres square and more, including not only the superficial layers of the skin, but the whole of the derma."

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From this it can be seen that there is nothing in common between the type advocated by Ollier and small deep grafts, except that the small deep grafts penetrate the full thickness of the skin at its centre. Ollier's grafts from his description were evidently what we now call full-thickness grafts. In size also they differ from small deep grafts, inasmuch as they were much larger, from four, six, and eight centimetres square, while the small deep graft should never be more than four or five millimetres in diameter.



Fig. 5A —The result of grafting an extensive granulating wound of the leg and thigh with Small Deep Grafts. The photograph was taken at the time of discharge from the hospital. On account of the magnitude of the wound two sessions were required to completely cover it. Note the individual grafts which were placed about 0.5 centimetre apart.

No one who is familiar with the subject now believes that Reverdin grafts are pure epidermic grafts. There is no question but that the appearance of a surface grafted with an Ollier-Thiersch graft in no way resembles one on which small deep grafts have been placed, but it must be borne in mind that the latter type of graft is used especially when we desire quick stable healing without special regard to appearance.

Small deep grafts most certainly do not merit the name of whole thickness grafts throughout their full extent as they include the full thickness of the skin only at the central portion, but it is obvious that they should be placed in the thick graft group.

*Classification.*—We frequently hear the terms, epidermic graft, dermo-epidermic graft and dermic graft. Is this a good classification? As it is impossible to cut a pure epidermic graft from normal skin with any apparatus now available, I feel that the term epidermic graft should be abandoned. Every type of graft actually belongs in the dermo-epidermic group inasmuch as the Reverdin graft, the Ollier-Thiersch graft, the small deep graft and the whole thickness graft all consist of epidermis with a varying thickness of the dermis. Dermic grafts actually mean whole thickness grafts and this is the only term of the three which is definite. Taking these facts into consideration, I have adopted a simple nomenclature based on the thickness of the grafts themselves and have separated them into two general types—*thin* grafts and *thick* grafts. In the *thin* group should be placed the original small thin grafts of Reverdin and the larger grafts of Ollier-Thiersch which, if properly cut, are of the same thickness. In the *thick* graft group belong the small deep grafts, and the whole thickness (Wolfe-Krause) grafts.

*Source of Grafts.*—Small deep grafts may be cut from any available portion of the skin, but where possible they should be taken from areas which are ordinarily covered by clothing, as the multiple small scars left after healing has taken place are unsightly. My preference is to use skin from the upper anterior surface of the thigh.

The region from which the graft is taken has little if any effect on the success or failure of the result, but I find that it is advantageous to take them from areas where the skin is not too thick. It is, of course, preferable to secure the grafts from the patient himself, and we can almost always find an available area of normal skin.

*Surface on Which These Grafts May Be Placed.*—These grafts may be successfully placed on a fresh wound, but ordinarily they are used on granulating surfaces. Granulation tissue suitable for grafting should be clean, firm, rose pink in color and not exuberant. There are many methods of preparing a granulating area for grafting, but I will not consider them here as each surgeon has his own ideas as to when the granulations are ready and how to prepare them. I feel, however, that I, personally, can tell more by the appearance of a granulating surface as to proper time to graft than I can by depending entirely on a bacterial count, as frequently a count may be high and the granulating surface may be clinically perfect for grafting and *vice versa*. If the appearance of the granulations is satisfactory and the bacterial count is low or negative, then we have the ideal condition, but in my own work I depend more on the appearance of the surface than on the count.



Fig. 5B.—The same area twelve years later. The patient has been working continuously since leaving the hospital. The skin is soft and movable over the underlying tissues. The individual grafts are still perfectly distinct and definite, and give a mottled appearance, otherwise the grafted area seems as stable as the normal skin. Note the absence of all contracture.

At times we are forced by circumstances to place these grafts on granulating surfaces which are not in good condition for grafting, and it is surprising how frequently they will take hold and live. In other words, small deep grafts will take on surfaces on which no other graft can survive except possibly Reverdin grafts.

*Preparation of Healthy Granulations to Receive Grafts.*—After the granulations are clean, flat and healthy, on the day preceding the grafting, a careful toilet of the unhealed surface and also of the surrounding skin should be made. The surface should then be covered with a thick, flat pad

of gauze saturated with normal salt solution and this pad should be allowed to dry out. Immediately before operation the gauze, after being thoroughly soaked with normal salt solution, is removed, care being taken not to cause bleeding, and the wound is washed with ether, followed by normal salt solution. The surface is then dried and a pad of dry gauze is placed over it and is pressed down firmly on the granulations. This gauze is peeled back just before the grafts are applied, as it is important that the surface to be grafted should be dry, but not glazed, because the grafts adhere more firmly to such a surface. The skin surrounding the granulating area may be cleaned by any method desired.
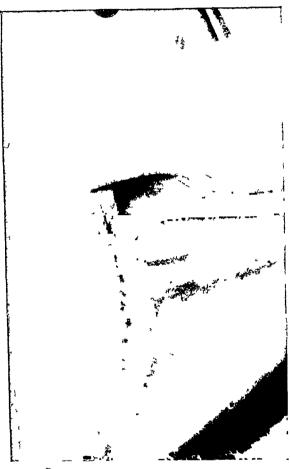


Fig 5C —The same leg flexed Note the well-formed popliteal space and the hamstring tendons standing out as if under normal skin

*Preparation of the Area from Which the Graft Is to be Cut.—* After the area is shaved, a thorough scrubbing with green soap and water, followed by alcohol and ether, is probably the best method of skin preparation. The following chemical methods may also be used with satisfaction— iodin, 2.5 per cent. several coats; 5 per cent. picric acid in alcohol; Potassio-mercurio-iodid (Kalmerid) 4 grams to 460 centimetres of acetone.

*Anæsthesia* —Ordinarily these grafts are cut under local anæsthesia, either induced by nerve blocking or by infiltration, and the process can be carried out with very little discomfort to the patient Infiltration seems to have little, if any, detrimental effect on the healing of the grafts, but all things being equal, nerve blocking is preferable. I do not care for massive infiltration, but to infiltrate only a small area at a time. It is seldom that general anæsthesia is used for cutting this type of graft, except in nervous children and excitable adults.

*Technic* —Place the patient in a comfortable position on a bed or a well-padded table. With experience one can tell quite accurately the approximate area of skin required to supply the necessary grafts, and this area is marked out in the shape of a rectangle or square with five per cent. brilliant green in alcohol. It is helpful to the assistant placing the grafts to have the marked out surface from which the grafts are cut lightly stained with

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brilliant green or some other dye, as then there is no difficulty in determining which is the epithelial surface. After the desired anæsthesia is induced a bit of epidermis is picked up on the point of an intestinal needle held firmly in an artery clamp and is raised so that a little cone is formed.* The base of this cone is cut through with a sharp scalpel, the blade being slightly tilted downward until the centre of the graft is reached, otherwise it will not include the full thickness of the skin. (By cutting through the tip of the cone with the blade level, we can obtain a thin Reverdin graft.) If the scalpel is made to cut toward the operator the shape of the graft is ordinarily nearly round or oval; if it is made to cut from the side, the shape of the graft is much more oblong. I usually cut the grafts in vertical rows running upward across the area marked out, and as the surface from which the grafts are cut is seldom level, it is advantageous to begin cutting each row at the lowest level, and to work upward, as in this way the field is kept clear of blood.

Properly cut grafts are preferably round or irregularly oval and vary between 0.4 and 0.5 centimetre in diameter. They are thickest in the centre, where the full depth of the skin is usually included, and taper off toward the edges where they are quite thin. There should be a narrow rim of undisturbed epithelium left between the pits made by cutting the grafts. The graft still on the needle may be transferred at once to the wound and placed with its raw surface on the granulations. If this method is used a number of clamps with needles will be necessary, each needle being flamed before it is returned to the operator, in order to avoid possible infection from the granulating area.

A simpler method and one which I now use most frequently is to dislodge the graft from the needle onto a folded towel where it is picked up on another needle by the assistant who is applying the grafts. This procedure also has the advantage of removing any blood which may be on the raw surface of the graft. The grafts should be placed in rows, raw surface down, a space of 0.5 centimetre being left between each graft, and no attempt should be made at this time to uncurl the thin edges which tend to roll under. After two or three rows have been applied a strip of rubber protective about 2.5 centimetres wide, in which "V" shaped slits have been cut, and long enough to extend well out on the surrounding skin is placed over the grafts so that the rows are covered. Then with a gauze pledget firm pressure is made directly downward on the protective and this will cause the edges of the grafts to uncurl and spread out on the granulations, and the thicker part of the grafts to come in close contact with the granulations at every point. More rows of grafts are placed and then another

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* Agnew, in 1874, suggested the point of a needle to raise the bit of skin to be cut in obtaining the Reverdin grafts. It has proved a simple and saitsfactory method to use when cutting small deep grafts as it raises the cone of the skin with the least possible trauma. Agnew, D. H.: Ulcers—Skin Grafting. Med. and Surg. Rep. vol. xxxi, p. 424, 1874.

strip of protective, which is laid so that it will partly overlap the one previously applied. This procedure is continued until the desired area is covered. The ends of the protective strips are secured to the skin by means of a few drops of chloroform. Sometimes, if the area is not too large, we place the grafts over the whole surface and then press them down with a smooth gauze pledget to uncurl the edges. A douche of hot air is then played over the grafted surface for a few minutes to set the grafts, and the protective strips are applied as described above. Sometimes strips of perforated cellosilk are used instead of rubber protective and may be secured to the skin by a solution of equal parts of absolute alcohol and ether.

An excellent method of immobilizing the grafts and holding them firmly against the granulating surface is to place a thin piece of sea sponge, cut to fit the defect, immediately over the protective and over this a thicker sea sponge, which projects beyond the grafted surface, the whole being secured under even pressure by means of adhesive plaster and a bandage. I still prefer to dress these grafts with overlapping strips of rubber protective rather than to expose them to the air for a number of hours. As far as I can determine, the use of the hot air douche will accomplish in a few minutes the same result (fixation by drying) as exposure to the air for several hours, but even when this method is used it will be noted above that the protective strips are also applied.

*Dressing of the Area from Which the Grafts Are Cut.*—Silver foil is the most satisfactory dressing for the area from which small deep grafts have been cut. Several layers of foil are applied and over this the porous paper which separates the leaves. Finally a flat gauze dressing secured with adhesive plaster and a bandage. This dressing is left undisturbed for about two weeks, and when it is removed the little wounds will be healed.

*Post-operative Treatment.*—The part should be immobilized, and if necessary the patient should be kept in bed for a longer or shorter period depending on the size and situation of the grafted area. When the grafts are placed on a granulating surface the dressings should be changed after forty-eight hours; when on a fresh wound the dressing may be delayed for a week. Frequently the grafts placed on a granulating surface and dressed with rubber protective strips will be found bathed in a creamy secretion, but they seem to thrive in it. This secretion should be gently mopped off or removed by irrigation with normal salt solution. Then again apply the protective strips and a sea sponge as at the original dressing. Within forty-eight hours after grafting, those grafts which will live become a dusky pink with a deeper blotchy area in the centre. Even at this early period a narrow halo of newly-formed epithelium can often be seen around each graft. Those grafts which do not take are white in color and will come away with the dressings in the course of a few days. The grafted area should be dressed every day after the first dressing and the protective strips should be applied for the second and third dressings, but with gauze over it instead of a sea sponge. After this some bland ointment spread on old linen is useful. When

the growth of the epithelium from the graft margins seems sluggish, eight per cent. Scarlet Red ointment will often cause stimulation of the growth. Compresses of gauze saturated with normal salt solution may also be used with satisfaction after the grafts have become firmly attached. Should the spread of the epithelium be slow and the granulations between the grafts become exuberant, compresses saturated with Dakin's solution may be used after the fifth day without harm to the grafts. As soon as the newly-formed epithelium from the grafts and the wound edges has fused, stearate of zinc powder and exposure to the air are helpful. The grafted area should be protected from injury for several weeks. About three weeks after healing has taken place gentle massage should be started and should be continued until the grafted area slides easily over the underlying tissues. Desquamation of the grafted area usually occurs and continues for several months after healing has taken place. This can be easily controlled by the application of cold cream or some other bland ointment.

*Comments.*—In plastic surgery conditions frequently arise which prohibit reconstructive work until the defect is healed so that asepsis can be secured. In such instances, these grafts are most useful as they promote a rapid, stable healing with very little waste of skin.

There are four main points necessary for the successful use of small deep grafts.

1. The granulating surface should be healthy, clean, flat and rose pink in color.

2. The grafts should be cut without unnecessary trauma; should usually include the full thickness of the skin at its centre and should be no larger than 0.5 centimetre in diameter.

3. The grafts should be placed on the surface of the granulations with an interval of 0.5 centimetre between them. They should be pressed down firmly on the granulations so that the thin edges will uncurl and so that every portion of the graft will be in close contact with the granulating surface.

4. The grafts should be immobilized until the new blood supply is assured.

Small deep grafts are used more frequently on granulating wounds than on fresh wounds. It would seem self-evident that it is necessary to place the raw surface of the grafts in contact with the granulating area to be grafted, but it has been said that these grafts will take equally well whether placed with the epithelial surface up or down. This may be true if the grafts are buried under the granulations, but my experience has been that any graft placed on a granulating surface with the epithelial side down, either accidentally or on purpose, will not live. The proper cutting of a small deep graft insures its close application to the surface on which it is placed without burying it in the granulations. In other words, when a graft is applied and pressed down, the thicker central portion goes quite deeply into the granulation tissue and every portion of the raw surface of the graft, even to the thin edges, comes in contact with the bed on which it is placed.

Should we actually punch out or cut up whole thickness skin into grafts

of the same size, they would project above the surface upon which they were placed and come in contact with the wound only at their bases, thus having much less of a surface through which to receive the new blood supply. They would also be hard to immobilize unless they were buried in little pits made in the granulation tissue, which procedure has been found inadvisable, as the grafts thus buried after their blood supply is assured are likely to be smothered by exuberant granulation tissue.

Almost invariably there is stimulation of epithelium from the wound edges following the application of these grafts, and successive graftings cause successive stimulations. When small deep grafts are placed at greater intervals than 0.5 centimetre apart the granulations between may become exuberant before the epithelium from the margins of the grafts can spread enough to cover them, and thus control the growth. Grafts may in this way be overwhelmed by granulations and in some instances are completely buried. When this condition occurs, the grafts are unable to spread and are sometimes absorbed. There is often considerable difficulty in reducing granulations which have become exuberant between the grafts without injuring the grafts themselves. The epithelium from each graft will spread over an area from 2 to 2.5 centimetres in diameter if the grafts are placed quite far apart, but the healing will be more stable if they are planted with intervals of about 0.5 centimetre between them.

There is marked shrinkage in the size of the original wound after grafting with small deep grafts. Contracture may occur in an area grafted with these grafts, especially in certain situations, for example, the axilla, but it is much less marked than would occur had the area not been grafted. On account of the dotted appearance of a surface successfully grafted with small deep grafts, it is inadvisable to use them on the face and other exposed positions except in special instances. Sometimes a brownish pigmentation may form in the grafted area but this also occurs in other types of grafts. Occasionally a keloid will form between the grafts and also in the area from which the grafts are cut, and there is no way to prevent this formation or to tell when it will occur.

A large number of grafts may be cut under local anæsthesia from a very small area with little discomfort to the patient. For instance, I recently counted thirty grafts taken from an area 3½ x 3½ centimetres. When we have a large granulating surface, it is frequently impossible on account of the condition of the patient or the lack of available skin surface to cover it completely with either Ollier-Thiersch grafts or whole thickness grafts. In such a case, small deep grafts offer the solution of the problem and may be applied here and there over the surface to start islands of skin; then, in a few days other grafts are placed between those already applied and so on until the new epithelium covers the area. It is seldom that we find the granulations on a large wound all in the same condition. Some parts may be ready for grafting and others may not, so in such a case the areas ready are grafted in the routine manner, with the grafts quite close together, as

described earlier in the paper, and later the other areas are grafted when they become fit.

It has been suggested that the healing of the little wounds left by cutting the grafts may be expedited by making oval grafts instead of the rounder shape and suturing each wound. This is hardly necessary as ordinarily the healing is prompt and the appearance of the scars of a sutured group of oval pits is little better than when suturing is not done.

Certain operators cut grafts from one to one and one-half centimetres in diameter and call them either Reverdin grafts or small deep grafts, neither of which titles are correct. These large grafts are unsatisfactory for several reasons: the result is more unsightly; there is not as much epithelial proliferation possible from the margin of a single larger graft as from several smaller grafts whose total area is the same as that of the larger graft; where available skin is scanty, more is wasted than when small deep grafts of the proper size are cut, and also the resulting scars are more objectionable. Healing is much expedited by the use of small deep grafts. The difference in the stability and character of the healing obtained after grafting with thin Reverdin grafts and with small deep grafts is almost as marked as that which is found between the results of thin Ollier-Thiersch grafts and whole thickness grafts.

The results with small deep grafts are uniformly satisfactory if the granulations on which they are placed are healthy and in proper condition. There is little doubt in my mind that these grafts persist as such, as we can see the definite little patches of normal-appearing skin in the grafted area years afterward. At one time, I was able to cut some of these grafts from a tattooed area and the pigment remained in them over a period of years. Frequently, hair will grow from the deep central portions of small deep grafts, if they are cut from a hairy area.

There is little to be gained in excessive speed in cutting and placing these grafts, and I feel that better results can be obtained when the procedure is carried out with ordinary celerity and not by the stop watch. Unquestionably, it is an irksome procedure to cut and apply several hundred of these grafts at one time, and it requires much more energy than would be used in obtaining a large Ollier-Thiersch or whole thickness graft. On the other hand, we must bear in mind that these grafts can be used successfully on surfaces on which no other type of graft, except the Reverdin graft, could take; that they may effect a cure on a patient too depleted to stand the greater operative procedure required in obtaining the other types of grafts; that a large surface may be grafted from a comparatively small area of skin. The use of small deep grafts is frequently disparaged, but in most instances by those who have had no experience with the method.

It is interesting to note that since this type of graft was developed, small deep grafts have been used at the Johns Hopkins Hospital on the vast majority of routine cases which require grafting, while previously at least 95 per cent. of the cases were grafted with Ollier-Thiersch grafts.

In my own work I use small deep grafts constantly and with the greatest satisfaction. They will cause the stable healing of wounds on which Ollier-Thiersch and whole thickness grafts cannot take. In fact, I could not get along without them when dealing with large granulating surfaces and with some of the complicated problems in wound healing.

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# IMPRESSIONS RESULTING FROM THREE THOUSAND TRANSFUSIONS OF UNMODIFIED BLOOD*

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During the past ten years we have made an effort to evaluate blood transfusions—to determine what benefit our patients were receiving from the generous use of transfusions in several conditions. At times we have been over-joyed at the results obtained. At times we have been disappointed. But, nevertheless, we have emerged from this ten years of study, during which we have performed over three thousand transfusions, convinced that the transfusion of blood will always be an important and valuable adjunct; a procedure with which we would be loath to dispense or even curtail; one to be used without hesitation in the sometimes rather complicated process of curing sick patients.

In attempting to determine the value of any treatment we must sacrifice a high degree of accuracy when dealing with human beings, because we usually have no control. Animal experimentation possesses certain advantages for which we cannot hope in clinical medicine and surgery. When we say that a certain method of treatment has reduced the mortality of a certain disease we have not, as a rule, one hundred cases which have received the treatment and one hundred cases which have not.

Even if such conditions were ever available, any doctor with human impulses would probably find himself instinctively deserting the rôle of pure investigator for that of healer, especially if the disease threatened to be fatal and if the remedy promised to be effective.

Thus our clinical opinions are robbed of precision, perhaps fortunately so, because mathematical precision would soon rob us of interest and enthusiasm. So when we say that we did a certain thing for a patient and the patient recovered, someone can always ask, "How do you know that the patient would not have recovered anyway?" The answer is, "We don't." Our intelligence and experience, however, prevent too great an error in our deductions and our conclusions are fairly accurate in spite of seemingly crude methods of clinical investigation.

A fairly large series of carefully observed cases has made it possible to state positively that blood transfusion has appreciably reduced our post-operative mortality and morbidity. It has made possible the successful operation of otherwise inoperable cases.

Many surgical cases come to us with pathology which has existed for a considerable period of time often associated with infection and toxæmia, and frequently secondary anæmia, rendering that individual poorly resistant to any

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added insult. Metabolism has been deranged. Oxidation of the tissues has been interfered with. The biochemical equilibrium is unstable. Surgical shock is a danger—acidosis always a possibility. One or more blood transfusions before operation usually changes the prognosis by wholly or partially restoring the proper physiological balance and normal biochemical equilibrium.

After operation the same indications exist. Frequently more blood has been lost at operation than we anticipated. Besides, it has been forcibly brought to our attention that we usually have a vague idea of the amount of hæmorrhage during an operation. Often when we would estimate the amount of blood lost to be fifty or a hundred cubic centimetres, several times that amount is more nearly correct.

Surgical cases usually need medical treatment as well as surgical. This is a point we sometimes overlook. In long-standing severe secondary anæmia we can invariably benefit the patient more in a few minutes by blood transfusion than in weeks and often months of drug administration.

There is one type of case with which we are all familiar: The post-operative case which, for no apparent reason, does not "do well." We have no definite diagnosis to apply, no scientific explanation to offer. There are no positive laboratory tests, no tangible physical findings. If death intervened, the pathologist probably could not throw much light on the situation because the pathology is often chemical and therefore invisible or, at least, ultramicroscopic. A scientific or clear-cut indication for a transfusion is lacking, but experience has shown that a transfusion in this type of case will often transport the patient from the realm of uncertainty to one of normal convalescence within a few hours.

We should not look upon blood transfusion merely as an emergency procedure to be used only in an attempt to save the life of a patient. We have given blood to many patients who doubtless would have recovered without it, but whose convalescence has been satisfactorily hastened thereby. To illustrate, we may consider a case of ruptured tubal pregnancy. The patient is usually markedly anæmic with a red blood count often around two millions. We know that the prognosis is fairly good and the patient probably will recover. But altogether too frequently we see these patients three or even six months after operation still somewhat anæmic, although sometimes not, but never having fully recovered good health. We know of no adequate explanation. But we do know that with a transfusion at the time of operation their recovery is often comparable to that following a simple appendectomy. The loss of a large amount of blood entails other factors besides the mere loss of corpuscles and hæmaglobin.

In septicæmias our results with blood transfusion have been somewhat erratic, but, for the most part, satisfactory. In infection without anæmia our transfusions frequently have been supplemented by mercurochrome intravenously or protein subcutaneously. It has been, therefore, rather difficult to arrive at definite conclusions as to the value of blood in these cases,

but there can be no doubt that, while the treatment is purely empirical, improvement has often followed transfusion.

In infection with anæmia, and there usually is anæmia, there is a definite indication for transfusion. Patients with hæmolytic streptococcic septicæmia should receive a transfusion every day or every second day. A frequent question has always been, "Doctor, when do you think the patient can have another transfusion?" The answer is, "Whenever necessary." No certain space of time need elapse between transfusions. Whenever a transfusion is indicated, give it, regardless of when a previous one has been given. I mention this because at one time we all believed that considerable time should elapse between transfusions—usually about a week. We now know there is no reason for such an attitude, but we find that impression still prevailing among some of our colleagues.

The most outstanding single derangement which our patients manifest is secondary anæmia. Most of these improve and return to normal on medical treatment. The cause is removed and the patient gets well. In a few such cases, search as you will, the cause of the anæmia is not discovered and any amount of medical treatment does not change the blood picture. Many of our "chronic invalids" are merely chronic secondary anæmias, together with an accompanying anxiety and exhaustion neurosis.

From a clinical standpoint two important factors govern the success of a transfusion when the indication is acute anæmia from hæmorrhage. One is the time which elapses between the hæmorrhage and the transfusion. The other is the amount of blood given. A hard and fast rule should be: if the indication for transfusion is sudden and severe hæmorrhage, an amount of blood should be given which is, as nearly as possible, equivalent to that which has been lost, as *soon* as possible following the hæmorrhage. One outstanding fault in transfusion work in connection with hæmorrhage is failure to give large enough amounts. There are patients to whom in the past we have given 500 cubic centimetres of blood who have lost three or four times that amount. Instead of using one donor, two or three should have been used. Disappointing results are often due to failure to transfuse early enough. The transfusion is frequently thought of and then given a day or two later, often too late. We are sometimes called in consultation to give a transfusion and find a moribund patient. Inquiry reveals that there had been a severe hæmorrhage a day or two before, but the doctor had procrastinated and really got busy when death became imminent.

Hæmorrhage, or rather the resulting acute anæmia, is a form of asphyxia. Asphyxiated tissues degenerate. Prompt and adequate restoration of the blood lost will arrest generalized tissue degeneration. Acute parenchymatous degeneration of such organs as the liver and brain continued over a considerable period of time constitutes a serious disease in itself which, when other pathology is present, is not easily repaired and becomes somewhat permanent. With this line of reasoning in mind, we aim never to allow acute severe anæmia following hæmorrhage to exist for any appreciable period of time.

From the standpoint of technic several things should be insisted upon. First, the blood should not be modified in any way. No anticoagulant should be used. Of course, circumstances sometimes alter one's actions. While citrated blood is not, to my mind, equal to whole blood, yet it would be foolish to advise against the use of citrated blood where a transfusion is urgent and no other method available. We discarded the citrate method years ago because of the high incidence of post-transfusion reactions, because we did not approve of the necessary technic, and because we did not obtain as good results as with whole blood.

Secondly, the blood should remain outside of the circulation only for a few seconds. Speed has never been found to be objectionable in a transfusion—rather it is a prime requisite and the keynote of success.

Thirdly, the blood should not be unduly agitated. Stirring or shaking should be eliminated.

Fourthly, the blood should not be exposed to the air. This precaution could hardly be observed in an indirect transfusion.

And lastly, the apparatus should be so simple that anyone can easily master the technic.

A frequent question has always been, "Do you use universal donors?" We do in the majority of cases. In about one-third of our cases the patient and donor are not in the same group, and I can state positively that there is no objection to such a procedure. Such a practice does not increase the incidence of post-transfusion reactions. Our reason for preferring Group IV donors is because we are afraid to use Group II donors with Group II patients. Our most severe reactions have nearly all occurred with that combination. We believe that there are two subdivisions of Group II which are often not strictly compatible. Fewer and less severe reactions have followed transfusion in which Group IV blood was given to a Group II recipient than in any other combination in our experience.

The donor and patient should be in the same group when more than one thousand cubic centimetres of blood are to be transfused. The donor's blood, even though it possesses the necessary agglutinins to clump the patient's cells, will not do so when added to the patient's circulation in the amounts ordinarily given. Theoretically it is possible, however, to give enough blood from this donor to raise the agglutinating titre sufficiently high to cause a disturbance. Ordinarily it is only necessary that the patient's plasma does not agglutinate the donor's cells.

I have touched very lightly on the indications for the transfusing of blood. I have given you a few of my impressions received as a result of observations made in a rather large number of transfusions at this clinic over a period of ten years. In the beginning we used the Unger apparatus which we later modified. For the last three years we have used the Brines apparatus which we have found satisfactory. This apparatus provides a continuous flow of blood from donor to recipient and the possibility of stagnation and subsequent

clotting is entirely removed. The veins are entered by needless and the exposure of veins is not ordinarily necessary. The minimum of assistance is required; one assistant is necessary, but can be dispensed with. The apparatus can be used in the patient's home or at the bedside as well as in the operating room. There are no automatic spring or ball valves to become coated with fibrin rendering the valve incompetent. No mistakes can be made such as reversing the flow as arrows indicate at all times the direction of flow. No foreign substance is mixed with the blood and strict asepsis is easily
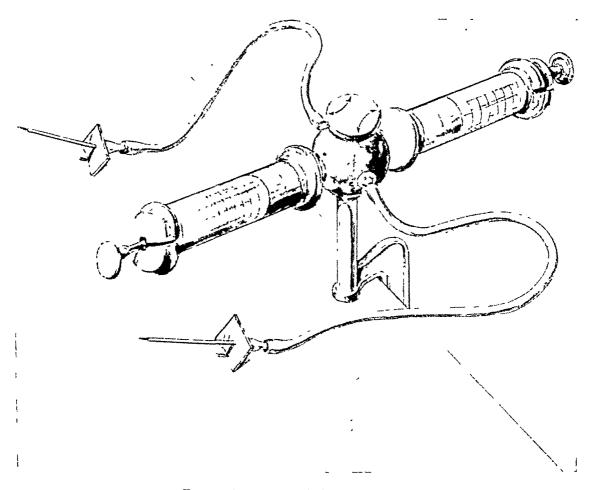
Fig. 1.—Brines' transfusion apparatus.

maintained. The blood can be accurately measured and only about five minutes are necessary for the actual transfusion. I am convinced that there is no simpler method.

We have used transfusions extensively and have been pleased with the results. We intend to use transfusions extensively in the future because we believe the procedure is worth while. There has been no mortality from transfusion in three thousand cases and in only about ten instances have we felt that the transfusion was in any degree harmful to the patient. There are few contraindications. We do not look upon blood transfusion as a panacea by any means. We usually give blood because of certain definite indications. One of the commonest reasons for transfusion in our work in the past has been a red blood count of less than three and one-half millions before operation.

## SUMMARY AND CONCLUSIONS

1. Favorable results obtained from three thousand transfusions have stimulated our enthusiasm regarding transfusions and have made us determined to extend the treatment, not only to frank anæmias, but to complicated surgical cases and bad surgical risks.

2. Even moderate anæmia before operation means prolonged and stormy convalescence after operation.

3. Severe hæmorrhage produces a deficiency of valuable blood constituents other than corpuscles and iron.

4. Chronic secondary anæmia, without apparent cause or persisting after the cause is removed, constitutes the basis of many cases of "poor health" and "chronic invalidism."

5. A simple method whereby unmodified blood can be rapidly transferred from donor to recipient should be employed and exposure of the blood to the air should be avoided.

6. Universal donors may be used safely.

7. A transfusion properly given presents practically no contraindications and produces essentially no reactions.

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# TWO CASES OF SUTURE OF STAB WOUNDS OF THE HEART

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The operative treatment of stab wounds of the heart is, and will remain, a relatively rare occurrence, but it is only relatively rare. There have been well over three hundred cases reported and it is rather curious that of this number only some fifty-odd have been by American surgeons.

As in so many other instances the application by the surgeon of well-established clinical and anatomical facts was very tardy. Block in 1882 reported the results of the surgical treatment of experimentally produced heart wounds, but in spite of this it was not until 1895 that an operation upon the human being was done. This was by Cappelan, a Norwegian. Other cases then followed rapidly until in 1926 three hundred and eleven cases were collected from the literature by H. H. Schoenfeld, who reported one at that time.

As to the operation itself, splitting of the sternum has been advised that better exposure may be obtained, but the incision most usually used is the hinge type of resection of the costal cartilages. These may or may not be replaced, at the discretion of the operator. Slightly better results have been obtained without drainage, but the tendency toward serious accumulation would suggest that the pericardium be very loosely closed if at all. Both linen and catgut sutures have been used with about equal success, but it seems obvious that in the extremely thin-walled right ventricle, and in the auricles, catgut is much superior. A doubled catgut suture is better than a single strand because of the tendency to ooze from the needle puncture. The placing of sutures so that they approximate the muscle but do not penetrate the endocardium may be easily accomplished in the left ventricle, but it is practically impossible in the thin wall of the right and probably equally so in the auricles. Its attempt might lead to untold troubles. Fortunately such a suture does not seem to be essential. Rotation of the heart should not be attempted, but lifting the heart from its bed seems to cause no disturbance and is the better method of obtaining exposure. A stay suture in the apex of the heart is almost invaluable, but must be handled with gentleness.

Reports of the two following cases in which a wound of the heart was sutured are submitted as a contribution to the statistics of the subject.

Case I.—C. P., a colored man, about twenty-five years of age, was admitted to the Good Samaritan Hospital November 3, 1928. He had been stabbed about one hour previously. He was delirious, extremely restless, his skin cold and clammy and of the peculiar ashen hue seen in the colored race when in shock. The radial pulse was only occasionally palpable and then a mere thread. At the left edge of the sternum, in the

third interspace, was a dry wound about two centimetres in length. The heart sounds were extremely distant, but clear. No definite increase in relative cardiac dulness could be demonstrated. The apex beat was absent. The lungs were clear in front and the patient was not turned to examine the backs. The temperature was 95.2° F.

Morphine was administered and while the operating room was being "set-up" an X-ray plate was made. This showed a tremendously enlarged cardiac shadow. During the two hours which elapsed between his admission and the beginning of the anæsthetic his condition improved considerably. Though still restless he was tractable and his pulse distinctly palpable with a rate of about ninety.

Under ether anæsthesia a parasternal incision was made and the third, fourth, fifth and six costal cartilages with a portion of the sternum were removed. About two double handfuls of blood clot and a considerable amount of free blood were removed from the pericardial cavity. The wound in the heart was difficult to expose because with the rotation in systole it disappeared from view. It was one centimetre long, almost vertical, and about five millimetres from the interventricular branch of the left coronary artery near its mid-portion. Apical stay sutures aided considerably in the closure of the wound with a Z-shaped catgut stitch. One stay suture was placed in the right ventricle and on removal the needle hole bled slightly, requiring a stitch to control it.

The internal mammary artery bled freely and was ligated with difficulty because it could not be well defined.



FIG. 1.—Case I. X-ray of chest showing increased cardiac shadow due to hæmopericardium.

Two small perforations in the pleura were closed while the pericardial cavity was being watched for further bleeding. The heart action was irregular during the manipulations, but was quite strong when the pericardium was closed. A protective tissue drain was left with its tip just inside the pericardial wound at the lower angle. The skin and fascia were closed with silkworm gut, the cartilages having been removed.

The bleeding from the wound in the heart in this case occurred chiefly during systole and this contributed to the difficulty in locating it. In spite of a moderately large hæmorrhage about three hours after the operation, which was caused by the poor ligation of the internal mammary artery, it was not felt that there had been sufficient loss of blood to require transfusion. Six and one-half hours after operation the patient's condition had improved. The pulse, which had been 120 per minute and of poor quality on leaving the operating table, was now 106 per minute and of fairly good volume. Within twenty minutes, however, the patient died. The wound was re-opened, a very small amount of blood found in the pericardial cavity and the sutures intact. On sectioning the heart a blood clot was found wrapped around the chordæ tendineæ in the right ventricle. The post-mortem was not carried further.

CASE II.—H. J., colored, male, twenty-five years of age, was admitted December 1, 1928. He was seen by Dr. S. Watson Talbert about fifteen minutes after having been

stabbed and was immediately given half a grain of morphine, the situation being fully recognized. At that time the man's radial pulse could not be obtained, he was semi-delirious and thrashing about, and his skin was cold, clammy and ashen-gray in appearance. Thirty minutes later he was still obviously in shock, but he was quiet and his pulse while weak was of surprisingly good quality. It was markedly dicrotic, but regular, and the rate was 88 per minute. His wound, located in the third interspace, was bleeding a little. It was about 1.5 centimetres in length and vertically placed. The temperature was 94° F.

Ether anæsthesia was begun one hour and forty-five minutes after admission. A flap incision was made hinged medianward. The fourth costal cartilage had been partly severed by the stab. The third, fourth and fifth cartilages were turned back with the intercostals at the sternal edge as a hinge. The pericardium was separated from their under surface by finger dissection. A small pleural wound was closed with a single catgut stitch and the pericardium, which was easily recognized because of the typical bluish color, was incised. About two double handfuls of blood clot were removed and a considerable amount of free blood sponged away. An oblique wound in the right ventricle, nearer the apex than the base, was easily located. It was about seven millimetres in length and approximately five millimetres, or a little less,



Fig. 2.—Case I. The wound is not well seen but the sutures indicate its location and the proximity of the vessels.

from the intraventricular branch of the left coronary artery and parallel to it. The wound bled only during diastole. One o chromic catgut stitch was placed and tied. This controlled most of the bleeding, but another stitch was necessary and it was placed lengthwise of the wound and at right angles to the first one because of the proximity of the coronary vessels. This suture was carefully tied with just enough tension to slightly pucker the wound and stop all bleeding. The cavity was thoroughly inspected and found dry before being closed loosely with a running catgut stitch. About one and one-half centimetres of the pericardial incision at its lower angle was left unclosed. The costal cartilages were replaced and muscle sutures depended upon to hold them. A protective drain was placed down to the injured area of the fourth cartilage.

The heart action was good during the entire operation, not more than half a dozen extra systoles occurring. During the operation 1000 cubic centimetres of salt solution was given by hypodermoclysis. At the conclusion of the operation the pulse was of fair quality and its rate was 100 per minute. Eleven hours later the temperature was 98.3° F. and the pulse, while still dicrotic, had a rate of only 96. The patient was quiet, rational and coöperative. He had been given one-half grain of morphine on admission, three-eighths grain immediately after operation, and one-sixth grain every three hours thereafter.

The blood pressure observations were quite interesting. Eleven hours after operation the systolic pressure was 162 and the diastolic 118 millimetres of mercury. The day after operation the reading was 142/105, and the third day 135/105.

By this time the patient had developed signs of definite pulmonary involvement over both fronts. He was not turned to permit examination of his back. He had a rather severe cough productive of fairly large amounts of green mucopurulent material.

On the fourth day the blood pressure was between 100 and 110 systolic and 70 to 80 diastolic. This indefinite type of reading was due to the fact that both the blood pressure and the pulse rate changed at intervals of from three to five minutes. By the seventh day the heart action had become quite irregular. The blood pressure was 120/80 as nearly as could be determined. Digitalis therapy was begun and resulted in a surprisingly
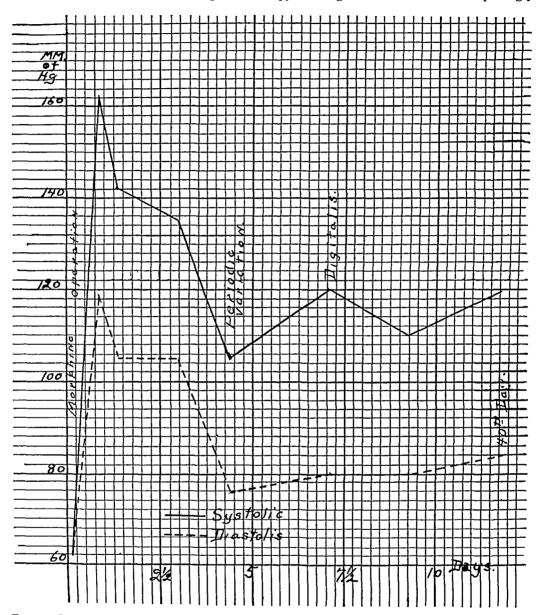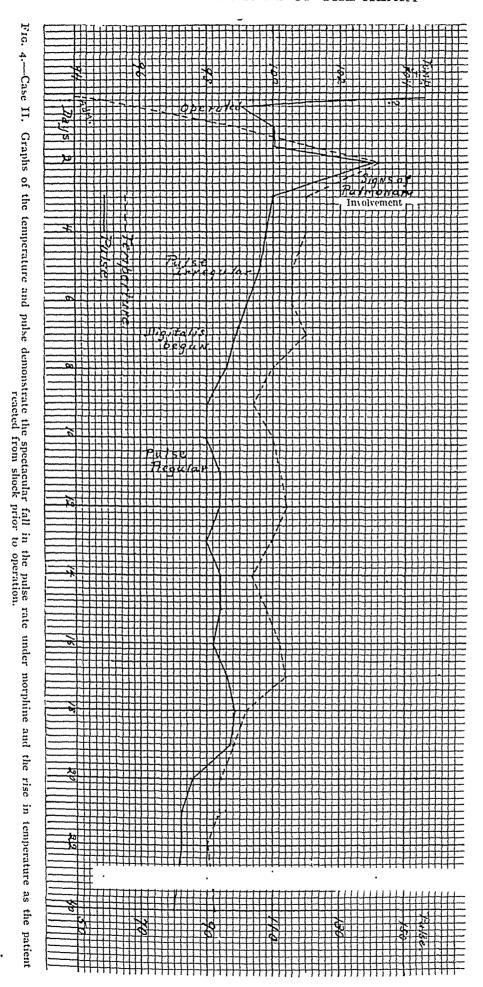


Fig 3 —Case II. Systolic and diastolic blood-pressure graphs showing the post operative rise in both. A somewhat similar systolic rise was observed by Beck in his experimental work on dogs.

prompt and gratifying return of the heart to its normal rhythm, and on the ninth day the blood pressure was 110/80.

A friction rub was audible over the apex on the seventh day. It soon shifted its location to the base, but did not disappear until the twenty-fifth day after operation. The lung situation cleared up very slowly. The temperature, which went above 102° F. on only one occasion, came down gradually. The wound healed cleanly except at the site of the original injury from which area a small amount of slightly cloudy, straw-colored fluid drained for some time.

Fig. 4.—Case II. Graphs of the temperature and pulse demonstrate the spectacular fall in the pulse rate under morphine and the rise in temperature as the patient reacted from shock prior to operation.

Dr. J. Heyward Gibbes very kindly examined the patient for us on the fortieth day. He found definite evidence of an adherent pericardium, but an entirely competent heart muscle, and his conclusion was that "this should result in a progressive cardiac hypertrophy and the ultimate development of myocardial insufficiency".

These case reports give a few observed facts that I have not found mentioned in the literature and which lead into interesting fields of thought. On both occasions about two hours elapsed between admission and the beginning of the operation. Morphine was given to each and during this period of waiting they both became quiet and the pulse improved tremendously. The rate in each one at the beginning of the operation was only ninety per minute. This would seem to indicate that the cardiac distress is at first due primarily to heart shock and that the mechanical factor of tamponade has either been overestimated or does not come into play as quickly as has been supposed. The absence of delirium cordis during the operations was quite striking, for it is prominently mentioned by most authors. This falls into line with the idea of a lessening of the cardiac sensitiveness by morphia.



FIG 5 —X-ray plate of chest in Case II on fortieth day. The cardiac shadow is slightly larger than normal.

The dicrotic character of the pulse in both cases and the rather sudden onset of arhythmia on the seventh day in the case that recovered were, most probably, simply evidences of an embarrassed myocardium. However, the changing character of the pulse and blood pressure and the post-operative hypertension are not so easily dismissed and are observations which, if previously made, have certainly not been prominently mentioned.

Digitalis was withheld on the theory that the major portion of the heart muscle being presumably all right the drug would throw an unnecessary strain upon the sutured area, yet it had a most salutory effect when it was instituted.

The behavior of the temperature and the clinical character of the lesions in the lungs suggest that they were due to small emboli rather than to a true primary bacterial invasion, and the post-mortem findings in the first

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case substantiate this. The complication is probably inherent in the lesion and deserves more consideration than it has had in the past.

If there be an outstanding conclusion that can be drawn from these cases it is that morphine, in large doses, both before and after operation, is the most important aid that we have and that even in so imperative an emergency there may yet be time to permit it to improve the patient's condition before the operation is begun.

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# END RESULTS OF SURGERY OF THE BILIARY TRACT

## A STUDY OF 634 CASES TREATED AT THE LAHEY CLINIC

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THE presence of stones in the gall-bladder or bile ducts, accompanied by its frequent associated symptoms, indicates the need for surgical intervention. For the non-calculous gall-bladder there remains considerable doubt as to the best method of treatment. This can best be answered by a study of the end results following different methods of treatment in different clinics. In this paper, we have tried to evaluate our surgical results in diseases of the biliary tract, as reflected by the operative mortality and symptomatic relief over an appreciable time. This report consists of the follow-up results of 634 private patients operated upon in the Lahey Clinic from 1910 to 1926. None has been included that has been followed for less than one year, while many have been seen more than ten years after operation. No reference to the clinical symptoms nor to the etiological factors will be made in this paper, although the clinical history was used in each case to determine the end result.

The only completely satisfactory follow-up is by personal examination. We have been able to do this in approximately 40 per cent. while definite information has been received from 84 per cent. Where examination was impractical, a questionnaire was filled out. The questionnaire * used seems adequate to determine the end result. Table I shows the source of the follow-up information.

### TABLE I.

| | |
|---|---:|
| Personal examination | 235 |
| Family physician's examination | 33 |
| Questionnaire * | 161 |
| Personal letter | 23 |
| Dead (hospital and remote) | 83 |
| Record incomplete or unsuccessful | 99 |
| Total | 634 |

It is obvious that many persons who have never suffered from gall-bladder disease have some of the indirect symptoms, such as gas and belching, and we have found it necessary to go over the symptoms and condition

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* QUESTIONNAIRE

1. Do you consider yourself well following your operation?
2. Have you had a recurrence of similar distress or pain?
3. Have you had jaundice since operation?
4. Do you complain of gas, belching, feeling of distention, or indigestion?
5. Have you had further operations or X-ray examinations?
6. Do you have other abdominal complaints?

found at operation to determine the end result, in order to ascertain that such symptoms were related to gall-bladder trouble.

These indefinite gastro-intestinal symptoms often alter an otherwise good result, but one cannot consider such a patient as a good result, although there is definite improvement. We have classified the results as good, improved, and unimproved. If there has been symptomatic relief, no recurrence of pain, and no incisional hernia, they were considered good results. When mild or periodic digestive symptoms persisted, possibly with discomfort or soreness in the wound without recurrence of pain or jaundice, or with post-operative hernia, they were grouped as improved. Patients suffering a recurrence of jaundice, typical pain, or the return of the pre-operative symptoms, were considered as unimproved. In the unimproved group, 10 per cent. were found in need of treatment for extra-biliary conditions, while 3 per cent. required further operation. In the 235 patients examined, fourteen post-operative herniæ were found—an incidence of approximately 6 per cent.

The classification of these patients according to the disease process is found in Table II.

TABLE II.

*Diseases of the Biliary Tract—634 Patients.*

| | | |
|---|---|---|
| Chronic cholecystitis | 181 | 28.6 per cent. |
| Cholelithiasis | 350 | 55.2 per cent. |
| Common duct stone | 52 | 8.2 per cent. |
| Cholangitis (alone) | 6 | 0.9 per cent. |
| Strictures of the ducts * | 12 | 1.9 per cent. |
| Carcinoma of the ducts | 3 | 0.5 per cent. |
| Miscellaneous | 30 | 4.7 per cent. |

The miscellaneous group includes abscess of the gall-bladder, acute pancreatitis and malignancy outside of the biliary tract requiring operations on the gall-bladder or ducts. These will be omitted from further consideration. Chronic inflammation was present in 524 gall-bladders (82.7 per cent.); acute inflammation in seventy (11.0 per cent.); while 453 (71.4 per cent.) had stones in the biliary tract. Acute inflammation was found in the presence of stones fifty-seven times and without stones thirteen times. The end results in the first group are reported with the gall-stone group, while the second have been placed with chronic cholecystitis. Ten were reported as normal by the pathologist. In each of these no other lesion was found at operation. In the group of chronic cholecystitis, seven were found to be of the so-called strawberry type. The 0.5 per cent. incidence of primary carcinoma of the ducts, exclusive of the ampulla of Vater, is higher than would be anticipated. The high incidence of stones in this series (71.4 per cent.) indicates that operation was advised usually where stones were present and was not advised for patients with chronic cholecystitis alone unless there were conspicuous clinical symptoms.

* Reported elsewhere by Dr. F. H. Lahey and Dr. R. L. Mason.

*Gall-stones.*—Gall-stones were found in 350 patients. Cholecystectomy was considered the operation of choice, and was done in 311 operations, while cholecystostomy was employed in thirty-nine. Whenever practicable, the appendix was removed at the same time. In addition, other operative procedures, exclusive of the biliary tract, were employed in fifty-five patients. The latter group we have considered separately in the follow-up figures, since it makes interpretation of the actual results more difficult. In this group of fifty-five patients, fifty had cholecystectomy, and five cholecystostomy. Table III (Part 1) shows the results in operations for gall-stones. The operative procedure in each will be considered later.

TABLE III.

*Gall-stones.*

Part 1

Results in 295 patients
 (Cholecystectomy .......... 261
 (Cholecystostomy .......... 34

| | | |
|---|---|---|
| Good ......................... 145 | | |
| Improved .................... 50 | 195 | 77.7 per cent. |
| Unimproved ................. 26 | 26 | 10.4 per cent. |
| Operative mortality ........... 17 | 17 | 6.8 per cent. |
| Remote mortality | | |
|  (other causes) | | |
|  (G-7, I-3, U-2) ........... 12 | 12 | 5.1 per cent. |
| Patients followed .............. | 251 | 85.0 per cent. |
| Patients not followed .......... | 44 | 15.0 per cent. |

Part 2

Results in 55 patients
 (Complicated by other operations)
  (Cholecystectomy .......... 50
  (Cholecystostomy .......... 5

| | | |
|---|---|---|
| Good ......................... 18 | | |
| Improved .................... 11 | 29 | 60.4 per cent. |
| Unimproved ................. 9 | 9 | 18.7 per cent. |
| Operative mortality ........... 4 | 4 | 8.3 per cent. |
| Remote mortality | | |
|  (other causes) | | |
|  (G-3, I-2, U-1) ........... 6 | 6 | 12.6 per cent. |
| Patients followed .............. | 48 | 87.2 per cent. |
| Patients not followed .......... | 7 | 12.8 per cent. |

Complicated by pelvic operations 33, GI-16, GU-3, others 3.

From these figures it will be seen that of the 251 patients followed, 77.7 per cent. were satisfactorily relieved. This should be the case in the typical gall-stone colic patient, and, if anything, our figures are lower than would be expected. In this group there were thirty-four patients who had cholecystostomy done. As will be seen later in this paper, the per cent. of patients relieved following this operation is small. Without this group the total good results would be raised well above 85 per cent. The operative mortality of 6.8 per cent. is high, but this has dropped below one per cent. for the past two years. The operative mortality includes all hospital deaths during

the post-operative convalescence from any cause. During the one- to fifteen-years interval since operation, twelve patients died of other causes. Information from our records and the patients' physicians gave about the same relative relief in these for the interval before death: ten were relieved and two were unimproved. We have not included these figures in the percentage given, since they must necessarily be inaccurate. Table III (Part 2) shows the results in operations for gall-stones accompanied by extra-biliary operations. It will be seen that the results are much less satisfactory than for gall-stones alone, and the mortality is appreciably raised. The explanation for the poorer results lies in the fact that the typical symptoms were less frequent, and at times only the so-called silent stones were present. We have largely abandoned the practice of combining other abdominal or pelvic operations with gall-bladder operations.

*Chronic Cholecystitis.*—Chronic cholecystitis, without the presence of stones, was found in 171 gall-bladders. These include gall-bladders (1) with thickened walls, (2) those with pericholecystic adhesions, and (3) those of the strawberry type. Removal of the gall-bladder with opaque thickened walls, often with interference in function, as shown by the dye test, has yielded a high per cent. of relief and there is little doubt that it should be removed. In the few instances where the gall-bladder appeared normal but had adhesions present, relief was consistently poor. In reporting the results no division will be made. The results in these patients are found in Table IV (Part 1).

TABLE IV.

*Chronic Cholecystitis.*

Part 1

Results in 146 patients
   (Cholecystectomy ........... 136
   (Cholecystostomy ........... 10

| | | | |
|---|---|---|---|
| Good ........................... | 52 | | |
| Improved ...................... | 23 | 75 | 64.1 per cent. |
| Unimproved .................... | 33 | 33 | 28.2 per cent. |
| Operative mortality ............ | 4 | 4 | 3.4 per cent. |
| Remote mortality | | | |
|   (other causes) | | | |
|   (G-1, I-1, U-2) ........... | 5 | 5 | 4.3 per cent. |
| Patients followed ......... ...... | 117 | | 80.1 per cent. |
| Patients not followed ........... | 29 | | 19.9 per cent. |

Part 2

Results in 25 patients
  (Complicated by other operations)
    (Cholecystectomy ........... 23
    (Cholecystostomy ........... 2

| | | | |
|---|---|---|---|
| Good ........................ | 7 | | |
| Improved ..................... | 6 | 13 | 59.1 per cent. |
| Unimproved ................... | 7 | 7 | 31.8 per cent. |
| Operative mortality ........... | 2 | 2 | 9.1 per cent. |
| Patients followed .............. | | 22 | 88.0 per cent. |
| Patients not followed .......... | | 3 | 12.0 per cent. |

Complicated by pelvic operations 6, GI-13, GU-3, others—3.

The 64.1 per cent. relieved in patients with chronic cholecystitis is considerably below that of 77.7 per cent. where gall-stones were present. While it does offer a reasonable chance of relief, it makes one hesitant to operate without the presence of stones unless there be a good reason for doing so. From the experience in the clinic and from the results shown by this follow-up study, we now feel that the gall-bladder with probable chronic cholecystitis found at operation should be removed when there is a history suggesting gall-bladder disease, when the intravenous gall-bladder dye test shows or is suspicious of pathology, and where other gastro-intestinal disease is ruled out by appropriate study. If we have found sufficient indication to operate for gall-bladder disease, then we believe the gall-bladder should be removed in the absence of other pathology to account for the symptoms. In the group of thirty-three not relieved by cholecystectomy, we have been able to submit over half of them to a gastro-intestinal investigation now. Dr. S. M. Jordan and Dr. E. D. Kiefer, of the gastro-enterological department in the clinic, have found many to be suffering from functional disturbance of the colon, which in some cases probably was the chief offender during the entire clinical course.* In most of the early cases the only X-ray studies were "plain plates" for possible demonstration of stones, and, failing to show these, operation was advised on the clinical history. At the present time a patient whose clinical history suggests chronic cholecystitis without stones undergoes a complete investigation with gastric analysis, gastro-intestinal series, barium enema, the intravenous tetraiodophenolphthalein test, and when diagnosis is made cholecystectomy is done, followed by treatment directed to the colon during the post-operative period. This is followed by dietary régime after leaving the hospital. It is possible that the large number of failures in operations for chronic cholecystitis parallels the large number of failures after gastro-enterostomy for ulcer, when after either operation a patient is given no post-operative instructions. We have had no experience with the non-surgical drainage in chronic cholecystitis, but from the extensive experience of others have not felt justified in using it. Dietary treatment, or treatment directed to functional disturbance of the colon, has not shown sufficient relief in patients complaining of these symptoms to justify either alone, but, combined with cholecystectomy, seems to offer the best assurance of relief to these patients.

In the group of 171 cases of chronic cholecystitis, seven were of the strawberry type. Of these, three were relieved and three unimproved, while one was not examined. This group is too small for comment. The incidence of cholesterol gall-bladder is much higher in our later cases.

In twenty-five additional operations for chronic cholecystitis, other operations complicated the results. Cholecystectomy in these cases was often done on account of adhesions or thickening, at times in the presence of peptic ulcer. The number relieved is somewhat lower, while the mortality is again markedly raised. Part Two of Table IV shows these results.

* These will be reported subsequently.

The pathologist reported ten gall-bladders as normal when the clinical history suggested gall-bladder disease. Only seven of these were examined. Four reported themselves as relieved, while two were unimproved. There was one death. The number here is too small to justify any conclusions.

*Common Duct.*—The surgery of the common duct has been of particular interest in this clinic, and the treatment of this condition in the past two years has become much more satisfactory. Fifty-two patients (8.4 per cent.) had stones present in the hepatic or common ducts. The majority were found near the entrance into the duodenum, in the portion of the duct that frequently becomes sacular. Stones were found in the hepatic ducts in eight patients. The number of stones varied from one to thirty-two. The end results are seen in Table V.

TABLE V.

*Common Duct.*

Part 1

Common duct stone
Results in 52 patients

| | | | |
|---|---|---|---|
| Good | 25 | | |
| Improved | 3 | 28 | 62.2 per cent. |
| Unimproved | 3 | 3 | 6.7 per cent. |
| Operative mortality | 6 | 6 | 13.3 per cent. |
| Subsequent mortality due to stones * | 5 | 5 | 11.1 per cent. |
| Remote mortality (G-2, U-1) | 3 | 3 | 6.7 per cent. |
| Patients followed | | 45 | 86.5 per cent. |
| Patients not followed | | 7 | 13.5 per cent. |

Part 2

Cholangitis
Results in 6 patients

| | | | |
|---|---|---|---|
| Good | 5 | | |
| Improved | 0 | 5 | 83.3 per cent. |
| Unimproved | 0 | | |
| Operative mortality | 1 | 1 | 16.6 per cent. |
| Patients followed | | 6 | 100.0 per cent. |

In the thirty-one patients surviving operation, twenty-eight (90 per cent.) were satisfactorily relieved. The three patients who had a recurrence of symptoms gave a clinical history again of common duct stones, while one of them had recurrence so soon after operation that we felt sure the stones had been left; three stones were removed at a subsequent operation. Such experiences have made us very careful in the exploration of the common duct. We will discuss this under the heading of choledochostomy. The presence of common duct stones is a very serious thing, as shown by the operative mortality of 13.3 per cent. We will be able to show later that this is not due to the technical difficulty of opening, exploring, and draining of the duct. The deaths were usually due to liver failure or so-called "cholemia," associated with high temperature, shock, and at times with urinary retention.

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* Deaths after leaving the hospital.

Although the great increase in coagulation time in deeply jaundiced patients may cause post-operative hæmorrhage and be a cause of death, hæmorrhage has not been a complicating factor in our six deaths. An important thing in this group is the occurrence of five deaths during the subsequent years after leaving the hospital, each apparently due to common duct stones either left at operation or to stones recurring in the ducts. This subsequent related mortality of 11.1 per cent. (five deaths) brings the total mortality to approximately 25 per cent. during the entire period. This high operative and subsequent mortality in common-duct-stone patients indicates to us that something must be done to lessen its occurrence. It is best accomplished by the early removal of all gall-stones. Thus it seems, with rare exceptions, all gall-stones, whether silent or causing clinical symptoms, should be removed, preferably by cholecystectomy.

Six patients showed dilatation, thickening, and acute inflammation of the ducts, at times associated with gross changes in the liver. In these no stone was demonstrated, although it is conceivable one might have been passed into the intestine. The criterion of diagnosis of cholangitis in these six patients has been jaundice, fever, pain in the right upper quadrant, without the presence of stones. The mucosal lining of the duct shows injection and the wall is thickened. These have been explored and drained for a long period of time, from fourteen days to three months. Some patients have been discharged from the hospital with a tube still in the wound. This tube can then be removed at a later visit. In one patient the ampulla was so large that the finger could be passed readily into the duodenum and there was obviously ample opportunity for regurgitation of duodenal contents. This patient became well after prolonged drainage and is now well after three years. The results are seen in Table V (Part 2). While there is frequent disappointment in the failure to find more pathology at operation, it is a satisfaction to know that these patients are usually relieved by prolonged drainage of the common duct.

*Type of Operation.*—Cholecystectomy is the operation of choice for either chronic or acute cholecystitis or for gall-stones, except in the very poor risk. During the early part of this fifteen-year period, drainage of the gall-bladder was done frequently, but has rarely been done during the past five years. The type of operation performed on these patients is shown in Table VI.

TABLE VI.

| | | |
|---|---|---|
| Cholecystectomy | 460 | 548 |
| Cholecystectomy and choledochostomy | 88 | |
| Cholecystostomy | 64 | 65 |
| Cholecystostomy and choledochostomy | 1 | |
| Choledochostomy | 7 | 96 |
| Coincident surgery at operation: | | |
|     Appendectomy | | 190 |
|     Gynæcological | | 42 |
|     Gastro-intestinal | | 17 |
|     Urological | | 4 |
|     Ventral Herniæ | | 7 |

There were fifty-two patients who had two operations on the gall-bladder or ducts: of these, twenty had their first operation elsewhere, while thirty-two were previously operated upon by us. Five patients required three operations. Follow-up information was obtained a year or more after the last operation in twenty-eight of these patients. In this group, twenty were relieved, four unimproved, and four died operative deaths.

In Table VI it will be seen that sixty-five cholecystostomies were done. Twenty-two of these returned to us suffering from a return of symptoms. Five we were unable to follow, but we know that none of the remaining thirty-eight patients was operated upon elsewhere.

Table VII shows the end results found in sixty-five cholecystostomies. Of the forty-four patients followed who were not subjected to a second operation, thirty-four were done for gall-stones and nine for acute and chronic cholecystitis. The elapsed time from operation to the return of symptoms in the twenty-two patients again submitted to operation varied from immediately after operation to twelve years. One required a second operation two months after the first, six during the first year, two after two years, two after four years, four after five years, five after seven to twelve years, while in two the time was not stated. The function of a gall-bladder after cholecystostomy as determined by the dye test is definitely interfered with. This can at least partially account for the poor results. The results following cholecystostomy are further shown to be poor by the fact that twenty patients came to us with a return of symptoms, having had this operation performed elsewhere.

TABLE VII.

*Cholecystostomy.*

*Results in 44 Patients not Subjected to Second Operation*

| | | |
|---|---|---|
| Good | 14 | |
| Improved | 3 | 17 |
| Unimproved | 18 | 18 |
| Dead | 3 | 3 |

*Summary of 65 Cholecystostomies*

| | | |
|---|---|---|
| Patients improved | 17 | |
| Patients unimproved and dead | 21 | |
| Patients having second operation | 22 | 43 |
| Patients not followed | 5 | |

It will be seen that of the sixty patients examined, forty-three, or 71.7 per cent., had a recurrence of symptoms, while only 28.3 per cent. were relieved. This is not a creditable showing for cholecystostomy. It is generally accepted at the present time that cholecystostomy does not give as good results as cholecystectomy. This is borne out by these figures.

*Choledochostomy.*—We have found exploration of the common duct a frequent necessity in biliary surgery. During the past two years the incidence has greatly increased. This incidence of duct exploration is seen in Table VIII.

TABLE VIII.

*Choledochostomy.*

|  |  |  |  |
|---|---|---|---|
|  | 179 choledochostomies in 909 operations .... | 19.7 per cent. |
| 1910–1926 | 96 choledochostomies in 634 operations .... | 15.1 per cent. |
| 1927–1928 | 83 choledochostomies in 275 operations .... | 30.2 per cent. |
| 1910–1926 | 52 common duct stones in 634 operations .. | 8.2 per cent. |
| 1927–1928 | 33 common duct stones in 275 operations .. | 12.0 per cent. |

It will be seen that one-fifth of all operations (1910–1928) on the biliary tract had exploration of the duct, while approximately one-third have had it done in the past two years. These figures are of particular interest, since in the period from 1910 to 1926, 15.1 per cent. of all patients operated upon had their common duct explored with the result that 8.2 per cent. of all showed common duct stones, while in 1927 and 1928, 30.2 per cent. of all patients had the duct opened, with 12 per cent. showing common duct stones. This shows that by doubling the frequency of opening the common duct the incidence of common duct stones in our cases is raised 50 per cent. We now feel that all common ducts should be opened, explored and drained which show any of the following points: dilatation, thickening, pancreatitis, presence of stones, or history of jaundice. Doctor Lahey has pointed out the not infrequent occurrence of stones in a duct which appeared and felt normal in a patient who gave no history of jaundice.

Stones were found in approximately one-half of all the ducts explored. This means that a large proportion of the remaining one-half were opened and drained that did not require this drainage for recovery, since only six were shown to have a definite inflammatory condition present in the duct itself. There are other causes of dilatation of the bile ducts exclusive of stones. Dilatation is known to occur after cholecystectomy. In approximately 20 per cent. of all the cases of gall-stones in this series, stones blocked the cystic duct. It is probable that this can produce dilatation, similar to cholecystectomy, since the gall-bladder may be actually shut out of the biliary system.

It may be thought that raising the incidence of exploration of the common duct may increase the operative mortality and the incidence of strictures. This is not the case. There has been no death in the past two years in which choledochostomy was done and no stones found. In the past eighty-three consecutive explorations of the duct we have had two deaths.

The first was a man sixty-one years of age, with a penetrating gastric ulcer which responded to medical treatment. · One year later he became jaundiced and had colicky pains in the region of the gall-bladder. At operation, under spinal anæsthesia, innumerable small stones were found in the gall-bladder and four stones were found in the common duct. Wound rupture occurred on the seventh day post-operatively, and although resuture was done with regional anæsthesia, he died two days later. The second death occurred in a woman forty-two years of age. At operation, under

spinal anæsthesia, the stones from the gall-bladder had ulcerated into the liver. Three faceted stones similar to those in the gall-bladder were found at the ampulla of the common duct and two others in the hepatic duct. She died ten days later and necropsy showed an extensive acute hæmorrhagic pancreatitis. It does not seem that the technical side of opening the common duct in these two patients was responsible for these deaths. There has been no patient in the past two years that showed persistence of jaundice or symptoms of stricture after drainage of the common duct, exclusive of primary stricture cases. From this experience we do not believe that the mortality is raised nor is the incidence of stricture increased by exploration of the common duct, properly done.

In this series of 179 choledochostomies, drainage has been done with a T-tube in all but four instances, and in these a catheter was used. Primary closure of the duct without drainage has not been practiced.

*Operative Mortality.*—In the period before 1927, the operative mortality (5.7 per cent.) was excessive. During the past two years it has dropped below one per cent. This considerable reduction in mortality seems due to a number of factors. During this latter period increasing attention has been paid to the preparation before operation. A high fluid intake has been insured by the subcutaneous and intravenous administration of fluid. Glucose was given in the same manner. This is important since there is frequently interference with the glycogen supply in the liver. The renal function was more closely estimated. The time of operation was coincident with subsiding jaundice when possible. The increased coagulation in the jaundiced patients was brought nearer normal by intravenous calcium chloride. Blood tranfusion has been used to improve coagulation and to combat shock. Extra-biliary operations combined with the operations on the gall-bladder have largely been abandoned. Quite probably patients have been coming to surgery earlier in the course of the disease and because of refinements in diagnosis earlier operation has been advised. Improvements in post-operative care have added to the ease and rapidity of convalescence. Finally, a very important factor in reducing mortality has been the employment of controllable spinal anæsthesia. This has been used in nearly all cases during the past year. In the first part of Table IX, the operative mortality of the past two years is contrasted with the period before 1927. In the second part of the table, the strictures, complete external biliary fistulæ, and malignancies of the ducts are listed.

Nearly one-half (eighteen) of the deaths resulted from surgical shock. Of these, six died after extensive operations for common duct stones in the presence of long-standing jaundice. The damage of the liver in these is probably an important contributory factor. Four patients died as a result of fatal pulmonary complications, with pneumonia and pulmonary embolism each occurring twice. Pulmonary complications after gall-bladder operations are reported between 1 and 3 per cent. The total incidence here has not been determined, but this fatal incidence of 0.4 per cent. is below the expected

figure. Acute pancreatitis was found at autopsy twice when there was no evidence of such a process at operation. Each time it occurred after common duct operations for stones. This finding indicates a relation between obstruction of the common duct by stones and acute pancreatitis.

TABLE IX.

*Biliary Tract Operations—Operative Mortality.*

| | | |
|---|---|---|
| 1910–1926 | 615 operations with | 35 deaths.......5.7 per cent. |
| 1927–1928 | 275 operations with | 2 deaths.......0.7 per cent. |
| 1910–1928 | 890 operations with | 37 deaths.......4.2 per cent. |
| | 12 operations for stricture | 2 deaths......16.7 per cent. |
| | 2 operations for complete external biliary fistula | 0 death |
| | 5 operations for carcinoma of ducts | 2 deaths......50.0 per cent. |
| 1910–1928 | 909 operations with | 41 deaths.......4.5 per cent. |

An analysis of the cause of death in these forty-one cases is shown in Table X.

TABLE X.

| | |
|---|---|
| Operative Mortality ........................... | 41 |
| Surgical shock ........................................ | 18 |
| Myocardial failure ................................... | 5 |
| Pulmonary embolism ................................. | 2 |
| Pneumonia ............................................ | 2 |
| Acute pancreatitis .................................. | 2 |
| Peritonitis ........................................... | 1 |
| Intestinal obstruction ................................ | 1 |
| Wound rupture ....................................... | 1 |
| Not determined ...................................... | 9 |

In summary, the end results in the important groups are given in Table XI.

TABLE XI.

*Biliary Tract Operations.*

*Summary of End Results up to 1927*

| | Satisfactory | Unimproved | Operative Mortality |
|---|---|---|---|
| Gall-stones ........... | 77.7 per cent. (195) | 10.4 per cent. | 6.8 per cent.* |
| Gall-stones complicated † ...... | 60.4 per cent. ( 29) | 18.7 per cent. | 8.3 per cent. |
| Common duct stone ... | 62.2 per cent. ( 28) | 6.7 per cent. | 13.3 per cent. 11.1 per cent.‡ |
| Cholangitis .......... | 83.3 per cent. ( 5) | | 16.7 per cent. |
| Chronic cholecystitis .. | 64.1 per cent. ( 75) | 28.2 per cent. | 3.4 per cent. |
| Chronic cholecystitis complicated † ...... | 59.1 per cent. ( 13) | 31.8 per cent. | 9.1 per cent. |

* The per cent. not followed is not stated.
† Results complicated by extra-biliary operations.
‡ Subsequent mortality due to recurrence.

## SUMMARY AND CONCLUSIONS

1. Cholecystectomy is the operation of choice for gall-stones and for acute and chronic cholecystitis, and should be done except in the very poor risk.

2. Cholecystectomy gives relief in a high percentage of patients with gall-stones.

3. Less than 30 per cent. of patients in this series having cholecystostomy have been relieved over a long period of time.

4. The operative treatment for the non-calculous gall-bladder is not satisfactory except where there is definite pathology present and conspicuous clinical symptoms associated with it.

5. The mortality after gall-bladder operations is shown to have been appreciably increased by doing other abdominal and pelvic operations at the same time. Such practice should be discouraged.

6. The operative mortality in patients with common duct stones is high. In addition, a considerable number operated upon for this condition have recurrence of symptoms, which results in a high subsequent non-operative mortality.

7. The early removal of gall-stones will reduce the incidence of common duct stones, and for this reason should be urged.

8. The mortality after operation on the gall-bladder alone is very low. In the past two years no death has resulted after such an operation.

9. Two deaths have occurred in the past 275 consecutive operations on the gall-bladder and ducts, exclusive of malignancy and stricture. Both were in patients with common duct stones.

10. The operative mortality after operations on the biliary tract has been reduced during the past two years.

11. By increasing the incidence of common duct exploration from 15 per cent. to 30 per cent. of all patients the incidence of common duct stones has been raised from 8 per cent. to 12 per cent.—an increase of 50 per cent.

12. It is obvious that exploration of the common duct should be done more frequently than is generally practiced.

13. In gall-bladder operations, the mortality is not raised nor is the incidence of stricture increased by exploration of the common duct, properly done.

14. There is a group of patients with symptoms commonly attributed to the gall-bladder, whose symptoms are due to functional disturbance of the colon. These patients respond to treatment directed to the colon.

15. Failure to obtain relief after operation for chronic cholecystitis is usually due to incomplete or wrong diagnosis.

# TREATMENT OF BILIARY FISTULA BY DIRECT IMPLANTATION OF THE TRACT INTO THE FIRST PORTION OF THE DUODENUM

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AND

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RECONSTRUCTIVE operations on the biliary tracts are comparatively common today. Implantation of the tract of a biliary fistula into the intestinal tract has been performed by Lahey,[1, 2] Masson,[3] Lilienthal,[4] St. John,[5] and Walters.[6, 7] The following case is being reported because, as far as is known, it represents the first successful anastomosis between the duodenum and the tract of an external biliary fistula. Over fifteen years have elapsed since this operation was performed. The patient is at present living and well and normal in every respect. He is now twenty years old and is in his second year at Law School. Up to a year and a half ago, the patient had occasional gastro-intestinal upsets, which were completely relieved by an appendectomy with drainage, at that time for acute appendicitis. In this case, the scar tissue tract was implanted directly into the first portion of the duodenum. The anastomosis consisted of two layers of sutures, the inner of catgut and the outer of silk. No rubber tube was employed. The wound was drained. It healed promptly, without leakage of bile. There have never been any signs or symptoms to suggest either stricture or ascending infection of the biliary tract since the operation was performed.

CASE.—The patient was a moderately well-developed boy, four years of age, who was admitted to the Children's Medical Service of the Massachusetts General Hospital for the first time August 28, 1912, with a diagnosis of mesenteric tuberculosis.

*Family History.*—Negative. *Past History.*—Full term difficult delivery. Birth weight, six and three-eighth pounds. Breast fed for seventeen months. Measles five months ago. Tonsillectomy in Out-Patient Department following this.

*Present Illness.*—Abdominal tumor; recognized for two months. During the past two years patient has had four to six attacks of vomiting. For the past two weeks the condition has been distinctly worse. There has been anorexia, night sweats, fever, distention of the abdomen and loss of weight. Patient has been fretful and easily irritated. Has recently had a slight non-productive cough.

*Physical Examination.*—Normal development of body framework; rather poor musculature; fair state of nutrition. The general physical examination was negative, with the exception of the abdomen. The liver dulness began at the upper border of the second rib and extended one centimetre below the right costal margin. Spleen enlarged and felt one centimetre below left costal margin. In the right upper abdomen, between the costal margin and the iliac fossa, was a visible tumor. The percussion note over this was of a reduced tympanitic quality. The mass had a soft fleshy feeling, was difficult to outline but seemed to be distinct from the liver and corresponded more to the position of the right kidney, greatly enlarged. The mass was not tender, had no pulsation, and did not move with respiration.

*Laboratory Findings.—Blood.*—Hæmoglobin 75 per cent. White blood corpuscles 12,700. Differential count: Polymorphonuclear leucocytes 66 per cent., lymphocytes 26 per cent., transitional cells 6 per cent., basophiles 2 per cent. *Urine.*—Light yellow, clear, acid, specific gravity 1.022, albumin 0, sugar 0, sediment—occasional granular cast. Renal function test—(phenolsulphonephthalein). No appearance of dye in urine at end of one, two, and ten hours. *Stool.*—Brown, homogenous. Microscopic examination negative. *Skin.*—Turberculin test negative at end of thirty-six hours.

The patient was seen by several consultants and was transferred to the Genito-Urinary Service on September 2, 1912, with a diagnosis of embryonic tumor of the right kidney. During his stay in the hospital his temperature had fluctuated between 98.8° and 100° F.

*Operation.*—September 3, 1912.—*Exploration and drainage of cyst of liver* by Dr. Hugh Cabot. Under ether anæsthesia a five-inch transverse incision was made just above the umbilicus, extending into the right flank. Peritoneum opened with the exposure of a cystic tumor the size and general shape of a grapefruit. It was covered by peritoneum and the ascending colon was adherent to its inner surface. Above, it was connected to the liver by strong bands containing fair-sized blood vessels. Posteriorly the tumor was attached to the deep structures and
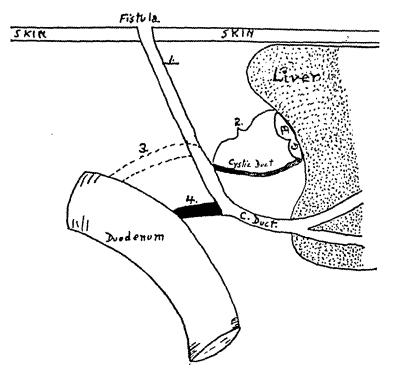


FIG. 1.—Diagram to represent the biliary tract in the case reported. 1. Tract cut off here. 2. Gall-bladder and cystic duct excised. 3. Tract implanted into duodenum. 4. Obliterated lower end of common duct.

could not be explored. Superiorly, a prolongation of the cyst extended upwards behind the liver. The gall-bladder appeared normal. The right kidney was normal. The peritoneum was stripped off the anterior surface of the cyst. Cyst opened with the escape of a pint or more of greenish, slightly viscid fluid. Cyst wall lined with smooth epithelium. Exploration of posterior wall of cyst from within made it seem unwise to attempt removal. As much of the cyst wall as possible was cut away. The cut edge sutured to the peritoneum, and the cavity packed with an iodine wick. Peritoneum, muscles, fascia, and skin closed on either side of the cyst. Patient sent to ward in good condition.

The patient remained in the hospital for eighty-one days; when he was discharged to the Out-Patient Department relieved. He drained bile profusely from the sinus made at operation. The stools became clay colored twelve days after operation and remained that way, occasionally showing a slight trace of bile. The child gradually went down hill for seven weeks, during which time he developed a pharyngitis, followed by cervical adenitis and bilateral otitis media. Both ears were drained. He then slowly picked up, under careful medical treatment, and was in fair condition at the time of discharge, although draining essentially all of his bile from the sinus.

*Pathological Report.*—Tissue removed at operation has the structure of a gall-bladder with inflammatory changes in the walls.

*Reëntry I.*—May 7, 1913. Since discharge from hospital five and one-half months ago, patient has done very well until five weeks ago. Attended the Out-Patient Depart-

ment regularly and took bile by mouth. The sinus continued to drain freely and the stools contained little bile.

During the past five weeks, the sinus has stopped draining several times. On each occasion, the child became ill, nauseated, constipated, and ran a temperature. With reëstablishment of draining the symptoms rapidly disappeared. Occasionally the drainage from the sinus was bloody in character. For several days before entrance, patient has had a temperature of 103° F. to 104° F. This afternoon vomited a large amount of black material and had a loose black bowel movement. Felt very weak after this.

*Physical Examination.*— Essentially unchanged except for marked pallor of skin. Several ecchymotic areas on extremities. Liver dulness within normal limits. Spleen not felt. Operative scar four inches long with a sinus in centre from which bile drains freely.

*Laboratory Findings.—Blood.*—Hæmoglobin thirty-five per cent., clotting time four and one-half hours. *Urine.*—Normal. *Stool.*—Strongly positive guaiac test, tarry in color.

May 8, 1913, patient was transfused by anastomosing the donor's radial artery to a vein in the patient's arm. Blood flow allowed to continue for forty-five minutes. Hæmoglobin following transfusion ninety per cent. Clotting time, five minutes. The tendency to bleed disappeared. The daily amount of ox gall by mouth was gradually increased from twelve to sixty grains. The patient gained steadily in weight, health, and strength and in seven weeks was considered in satisfactory condition for operation on his persistent and complete biliary fistula.

*Operation.—*June 25, 1913.—*Cholecystectomy and choledochoduodenostomy* by Dr. Hugh Williams. Under ether anæsthesia a circular incision was made about the old sinus and the abdomen opened by excising the old scar. There were many omental adhesions to abdominal wall in the vicinity of the fistula and many adhesions about the tract itself. Separation of these adhesions revealed an hour-glass gall-bladder about the size and shape of a large double peanut, with its cystic duct entering the fistulous tract about one and one-quarter inches below the abdominal wall. Gall-bladder opened and found to contain clear mucus. The cystic duct could not be probed from either end. The gall-bladder and cystic duct were removed, the duct being tied with fine silk. Adhesions further separated about the fistulous tract, and this was found to be continuous with the common duct, which was not particularly enlarged. Probe easily passed down the fistula, up the common duct and into the hepatic ducts. The duodenum was normal and lay nearby. There was a prolongation of the common duct to the duodenum, but it could not be probed and was apparently obliterated. An intestinal clamp was applied longitudinally to the duodenum, the gut opened one-quarter inch, and an anastomosis made between the end of the fistulous tract and the side of the duodenum. An inner layer of No. 0 plain catgut and an outer layer of fine continuous silk were used. A Miller wick was placed to the site of the anastomosis and the wound closed in layers.

The patient made an excellent recovery, and stools passed the following day contained a large amount of bile. The convalescence was uneventful and patient left the hospital in forty days, in very good condition. The abdominal wound was well healed and the stools were normal in character.

*Reëntry II.*—May 28, 1919. Since discharge from hospital, August 4, 1913, patient was perfectly well until two years ago. Since that time has had frequent attacks of epigastric and lower abdominal pain, associated with vomiting and fever. Bowels have moved regularly and stools have been normal in character.

June 2, 1919, a negative gastro-intestinal series was obtained and patient was discharged June 5, 1919, with diagnosis of post-operative adhesions.

*Reëntry III.*—February 19, 1927. Since last entry patient has been well with the exception of intermittent attacks of sharp colicky pain throughout the abdomen, with no definite localization. The pain did not radiate and was always accompanied by vomiting. Yesterday morning, at 2 o'clock, patient was awakened by pain in his right lower quadrant which was severe and colicky in character. Vomited once, almost immediately.

The pain and nausea has continued and his local doctor sent him to the hospital with a diagnosis of acute appendicitis.

*Physical Examination.*—Marked tenderness and moderate spasm over lower third of right rectus muscle. Tenderness on right side of pelvis by rectum. Temperature, 100.4 R.; white blood cells, 14,000. *Urine.*—Negative.

*Operation.*—February 19, 1927. Under ether anæsthesia a right rectus muscle splitting incision was made because it was felt that there would be less difficulty should adhesions from previous operation be present. An acutely inflamed appendix lying in the right side of the pelvis was removed. There was a small amount of pus about the tip of the appendix. Appendix removed, stump invaginated, and a Miller wick inserted to the point where the tip of the appendix had lain. Wound closed in layers.

Patient made an uneventful recovery and was discharged on the fourteenth day cured.

*Pathological Report.*—Appendix 5.5 centimetres in length. It is swollen, injected and the walls are œdematous. Acute appendicitis.

## CONCLUSIONS

1. The tract of a biliary fistula may be implanted directly into the first portion of the duodenum.

2. This procedure is particularly indicated in cases where the lower end of the common duct is obliterated or difficult to locate.

3. The biliary system may function normally for many years (fifteen) after such an operation without evidence of stricture or ascending infection of the ducts.

4. Feeding large amounts of ox bile by mouth was found to be an effective method of controlling hæmorrhage in this case. It has subsequently been found of benefit in reducing hæmorrhage in cases of obstructive jaundice, suggesting that absence of bile from the intestinal tract is related to the bleeding tendency of cases of complete biliary fistula and obstructive jaundice.

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# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

### STATED MEETING HELD FEBRUARY 4, 1929

DR. JOHN H. JOPSON in the Chair, DR. CALVIN M. SMYTH, JR., Recorder

### NEPHRECTOMY FOR UNILATERAL POLYCYSTIC KIDNEY

DR. A. B. THOMAS reported the case of a woman, married, thirty-one years of age, who was admitted to the Presbyterian Hospital on account of an increasing tumor in the left loin. Formerly had to rise once during night to urinate. Had gained sixteen pounds in weight the last few months. Urine: amber, specific gravity 1.018, no albumin, no sugar, no casts, no red blood cells, average two to four white blood cells per high power field, many epithelial cells. Blood count: red blood cells 4,760,000; white blood cells 8500; polymorphonuclear leucocytes 60 per cent., small lymphocytes 28, large lymphocytes 8, transitionals 2 per cent., eosinophils 2 per cent. There was no hypertension. There was an exophthalmic goitre, which had been present for six months, and a large tumor in the left loin which was thought to be kidney.

Cystoscopy revealed a normal bladder and normal ureteral orifices. Indigocarmin given intramuscularly appeared from the right side in seven minutes and from the left side in eight minutes, but only about one-fourth the amount on the left side as compared with the right, and less intensely colored blue. Ureters were catheterized and the urine obtained revealed a few red blood cells and white blood cells from each side.



FIG. 1.—Unilateral Polycystic Kidney removed by nephrectomy.

A left nephrectomy was carried out on September 9, 1915, delivering a large polycystic kidney. An abdominal incision was first made. The tumor definitely seemed to be the kidney; the opposite kidney was palpated and no evidence of cystic degeneration noted so that wound was closed. Then a lumbar incision was made and the nephrectomy carried out extraperitoneally. The patient made an uneventful recovery. A letter from her physician dated November 22, 1928, stated that about three years after the operation she moved to the Middle West and that he had not been able to get in touch with her since, but up until that time she had been in perfect health.

Doctor Thomas remarked that polycystic kidneys are, perhaps, the most interesting of all the anomalies of the kidney. Naumann found sixteen cases in 10,177 post-mortem examinations, of which fourteen were bilateral. Sieber collected 244 cases from the literature and stated that the bilateral cases outnumbered the unilateral cases ten to one. It is interesting to note that in Sieber's nine unilateral cases, six were on the left side, which is declared to be the more common in the unilateral cases.

Recently he had a case on his service at the Graduate Hospital: a unilateral polycystic kidney, discovered at autopsy, which was on the left side; also, the case which is reported tonight was on the left side.

Females predominate in the analysis of sex. Apparently there is a marked predisposition for the disease to appear in families, and it has been reported in more than one generation. Osler refers to a mother with five children, all with poly-



Fig. 2.—Cut-section of Unilateral Polycystic Kidney removed by nephrectomy.

cystic kidneys. Ball reports polycystic kidneys in three generations. Rochert reports, in the attempt to cross St. Bernard dogs with bassets, both ways, all the pups died within a week after birth and were found to have polycystic kidneys. This was thought to be due to failure of the two systems, from which the kidney is formed embryologically, to unite.

Nothing new has been added in the last few years with regard to the pathogenesis in such cases, although while there is general acceptance of the theory of the failure of the two embryological structures to unite, still it has been reported by several workers that dye injected into the ureter has appeared in the kidney showing that there is a direct communication. There are often many associated lesions such as hypertrophy of the heart, arteriosclerosis,

cysts of the liver, and often many other congenital lesions, occurring in the same case. While the cysts occur from birth to the eightieth year, the greatest incidence is usually from forty to sixty years, and the clinical picture is often divided into: (1) Progressive enlargement; (2) the presence of a tumor together with subjective pain such as hematuria, pyuria, etc.; (3) uremia.

The duration, after symptoms have developed, is anywhere from ten to twenty years. The average course is not more than five to six years. According to Goinet and Rabaud death occurs immediately in 50 per cent. of the cases. Nephrectomy is usually employed only as a last resort because most cases are bilateral and the mortality has been exceedingly high. Deaver states that it is not enough to go by the palpating hand to be assured that the other kidney is not polycystic, because in four such cases in which he did nephrectomy, when the other kidney to a palpating hand did not reveal any cysts, three died within three years of polycystic degeneration of the other kidney.

Morris reports that out of five nephrectomies for polycystic kidneys two were living and well three years and seven years, respectively, after the operation; two died within a few days, while one lived a few weeks. Torrence: one living and well two years after operation. Albarran and Imbert report twenty-five operative recoveries in thirty-four cases, in which fifteen of the patients survived from several weeks to seven years afterward; six had probable recurrence in the remaining kidney, two to three years after operation.

Sieber, in sixty-two operative cases, reported a mortality of 33 per cent. and rapid recurrence in ten cases, the remainder being well eight months to seven years after operation. Brin reported nephrectomy in seventeen cases, and Blatt, in nine cases. In twenty-two cases of nephrotomy and nephrectomy the mortality was 31.8 per cent., and only two patients were alive after two years. Employing the Rovsing operation, Brin reported sixteen cases with four operative mortalities, or 25 per cent. The Mayos report fourteen nephrectomies with one operative death, one died of pelvic malignancy very shortly afterward, nine were living and well from, two at two years up to one at ten years. Employing the Rovsing operation in ten cases, seven of which were diagnosed before operation, two died following the operation and one lived for three years, four were living at one year, one at two years, one at three years, and one at five years.

In the case now reported the cysts were confined mostly to the lower two-thirds of the kidney and, perhaps, this has something to do with the fact that it was unilateral and that at least for three years, if no longer, the patient remained free of symptoms on the other side.

DR. CHARLES F. NASSAU said that he had operated upon but one patient with a right-sided unilateral polycystic kidney. After exposing the kidney he recognized the condition and in order to determine the condition of the left kidney he opened the peritoneum and palpated the other kidney, which was apparently normal. The entire right kidney was involved as in the congenital condition. The woman recovered and is perfectly well as far as is known.

These lesions must be rare because in the course of years the speaker has had a good many kidney cases and this is the only instance he remembers of true polycystic kidney.

Dr. George Outerbridge spoke of the Rovsing operation, in which he was interested because of a case recently under his care, of a colored woman who was referred to the hospital with the diagnosis of large ovarian cysts. The abdomen was markedly distended, with irregular cystic masses, which on superficial examination certainly suggested that diagnosis. However, from pyelograms it was diagnosed definitely as bilateral polycystic kidney, but as the masses were so large and apparently multiple, he thought it justifiable to make a small exploratory abdominal incision to be certain that he was not dealing with a combination of the two conditions, and that some of the cysts might be ovarian and therefore removable. This, however, was found not to be the case, the cystic masses being entirely renal, the left kidney being almost the size of a small football and the right somewhat smaller, but still very greatly enlarged, and cystic. He did not wish to puncture any of these cysts through the peritoneal cavity, and as any thought of removal was entirely out of the question, the abdomen was closed and nothing further done. It would seem, however, that this might possibly be a suitable case for the Rovsing operation.

## X-RAY DESTRUCTION OF KIDNEY

Dr. Alexander Randall presented a man who entered the University Hospital in May, 1925, with acute appendicitis. An appendectomy was done by Dr. I. S. Ravdin and, though convalescence was complicated by lobar pneumonia, he made a complete recovery during the next two years. During these two years he had, at times, pains of dull character in the lower abdomen to the right of the mid-line, and referred to the pelvis. There were no acute symptoms and the patient attributed his discomfort to bowel irregularity. There were no urinary symptoms.

He was re-admitted to the University Hospital two years later, in April, 1927, because of his lower abdominal discomfort. X-ray was negative for calculus. The urine showed white blood cells and red blood cells but was negative for the tubercle bacillus, and a pure culture of non-hemolytic staphylococcus was found. His condition was felt to be pyelitis and he was sent back to his family physician with advice.

The pain in the lower abdomen continuing, he was again admitted to the hospital a year later (March, 1928). His pain now was continuous and at times sharper and cramp-like. Hæmaturia had been noted on two occasions during the past year, though his major complaint was lower abdominal pain and considerable digestive disturbance, flatulence, cardiac palpitation, dragging weight in abdomen, though no nausea or vomiting, and no bladder discomfort. An operation was performed by Dr. George P. Muller, under a tentative diagnosis of post-operative adhesions, on March 17, 1928. The peritoneal cavity was found to be normal. In the right iliac fossa a hard calcareous mass was felt behind the posterior peritoneum. Incision over it, with the expectation of removing a calcified retroperitoneal lymph gland, delivered a ureteral calculus. The ureter being opened, drainage was established by placing a tube retroperitoneally, giving it an exit through a second-

ary incision directly medial to the anterior superior iliac spine. Further examination revealed the right kidney lying directly under McBurney's point, markedly ptosed, but fixed in that position. Four weeks later he was discharged with a patent urinary fistula to regain some strength before nephrectomy was done.

He was re-admitted to the hospital in May, 1928, and pyelographic studies confirmed the suspicion of ectopic right kidney, and on May 10, 1928, Doctor Muller performed a right nephrectomy extraperitoneally. The organ was tightly adherent and very difficult to mobilize. It was removed in three portions and all major vessels doubly ligated. Gauze drainage was instituted. Forty-eight hours later a transfusion was given and the same repeated three days subsequently. He was discharged convalescent four weeks later with a wound healed to a small sinus that continued to discharge.

The patient was re-admitted in November, 1928, on account of the persistent urinary fistula. Various cystoscopic and pyelographic studies established the fact that there was no connection between the bladder and the fistula; that there was a normally developed and functioning left kidney and ureter and allowed of but one conclusion, *i.e.*, the persistence of some portion of the ectopic kidney still viable and functioning through the persistent fistula. Indigocarmin administered intravenously, while showing prompt and normal elimination per bladder from the left kidney appeared as the faintest tinge of color from the fistula, and the same result was obtained with repeated phenolsulphonephthalein tests.

Discussion centred on the relief of this distressing condition without subjecting the patient to further operative measures, and recalling the work of Hartman and his associates in producing marked interstitial nephrosis in experimental animals by X-ray, it was felt that the remnant of this ectopic kidney might likewise be destroyed by radiation. Hartman's efforts were to produce chronic interstitial nephritis in animals for experimental purposes, which he unquestionably accomplished to the point of producing uræmia and death, but he does not hint at the possibility of this pseudosurgical use of the measure. November 22, 1928, this patient received his first treatment and was given five daily exposures of thirty minutes each. The day following his first exposure the drainage was definitely increased and on the next day there was almost no drainage at all. He was discharged on the last day of treatment, November 27, 1928, with unquestionably reduced drainage. Returning January 8, 1929, he reported but little change in the amount and was given five further exposures, ending January 15, each of thirty minutes' duration. Feeling that the failure of the first series was due to the too limited application, this second series of exposures were given to cover a greater area. It was not until after beginning the above X-ray treatment that justification for the same was found in the recently published article by Kline, who reports four cases of post-operative ureteral fistulization in each of which the kidney involved was caused to cease secreting by X-ray destruction.

Dr. Thomas C. Stellwagen asked if smears were made from the sinus and analysis made of the discharge. He has had occasion to treat three such cases. One patient had had a stone removed from the kidney. He had a stone-forming kidney and also had an obstruction further down in the ureter and would not submit to further surgery when the condition returned. At present this man is perfectly well because his sinus is closed. Finally, after numerous X-ray exposures the kidney ceased functioning, but whether or not

the kidney is absolutely out of commission is uncertain. He submitted to only one cystoscopy which showed the kidney was not functioning at all. This case is one which is comparable to the case shown by Doctor Randall, that the kidney ceased to function following X-ray.

DR. ALEXANDER RANDALL said that Doctor Stellwagen raised the question as to whether the urine from the sinus had been analyzed. With the patient in a certain position he was able to collect two-thirds of a test tube of fluid from his fistula in three-quarters of an hour's time. Analysis showed the usual urinary salts present though in very low concentration. The same was true of both the indigocarmin and the phenolsulphonephthalein dye tests, the amount obtained being too low for estimation.

In regard to the work which Hartman and his co-workers have done at the Ford Hospital, it is of interest to point out that they were able to cause such a high grade of experimental nephritis as to produce coma and death from typical uræmic symptoms (including blood studies) in their experimental animals. They were interested only in this side of the question and have not considered its surgical application. Kline, on the other hand, has reported four cases of ureteral fistula following Wertheim hysterectomies, and in each case was able to put the involved kidney completely out of function by X-ray exposure. Apparently in two of his cases the involved kidney was of equal function to that of its mate before X-ray treatment was instituted. Doctor Randall stated that his is but a preliminary report, and he hoped at a later date to be able to report the case as a permanent cure.

## NEW GROWTHS OF THE RENAL PELVIS

DR. LEON HERMAN and DR. LLOYD B. GREENE (by invitation) read a paper with the above title for which see page 682.

DR. JOHN T. BAUER remarked that the first case mentioned by the essayists appeared to be histologically a papilloma of low-grade malignancy. The second case which Doctor Herman thought to be a flat carcinoma is quite malignant, infiltrating the parenchyma of the kidney, and vaguely suggests a papillomatous origin. The other cases which were examined involved the pelvis and did not extend into the renal tissue.

In regard to malignancy the papillomata of the renal pelvis are similar to those of the bladder, that is, they may appear histologically benign and be clinically malignant. The delicate character of the fronds, the ease with which they break and may become implanted in the ureter and bladder may explain this malignant tendency. It is interesting to comment upon the early symptom of hæmorrhage in these cases. This may be due to the rupture of the vessels in the delicate fibrous trabeculæ when the papillary tips are broken.

DR. PAUL A. BISHOP said that coöperation between the urologist and the röntgenologist was essential when interpreting films in these cases. There are so many things that these defects and distortions of the pelvis can be due to. The presence of a circumscribed defect in the kidney pelvis is not

enough to diagnose papilloma. A stone which is non-opaque or a blood clot, which is likely to occur in these cases, may also stimulate this appearance, but a localized distortion of a calix or two calices and a filling defect at the base of it are suspicious even from the pyelogram alone. The speaker has suggested that Doctor Herman try flattening the kidney pelvis by using pressure before the medium is injected, as he is sure it will improve the results from pyelography.

Dr. B. A. Thomas said that pyelography of the kidney pelvis is one of the, if not the most, interesting fields in urological diagnosis. Contrary to the infallibility of pyelography in the diagnosis of papillary tumors of the kidney as stressed by Doctor Herman and Doctor Greene, they have shown by the citation of cases in their own paper, at least by one of them, that it is impossible to differentiate between certain solid and papillary tumors. All know that in the majority of cases a filling defect of the renal pelvis is diagnostic of a papillary growth. Characteristic though it may be, it is not, however, infallible.

In a case which came under the speaker's observation and was operated recently, and which was included in Doctor Herman's and Doctor Greene's presentation, the pyelogram showed a definite filling defect of the lower calix of the renal pelvis, characteristic of papilloma, but at operation a large hypernephroma occupying the lower pole of the kidney was removed. The calix had not filled fully owing to compression by proliferation of hypernephromatous growth. Also, within the past year, he has seen two patients thought by pyelography to have papillomata of the kidney pelvis or calices, but at operation calculi were found and had doubtless caused the filling defects. Therefore, one must not be too dogmatic or arbitrary concerning the interpretation of renal pelvic filling defects. In the future it may be possible to differentiate unerringly in the pyelograms of kidney tumors—the solid from the papillary—but today one cannot be too sure with respect to this differential diagnosis.

Doctor Thomas did not quite agree with Doctor Herman in regard to indigocarmin in tuberculosis of the kidney. His experience has been that it has been well nigh infallible, and the best aid at our command in the diagnostic management of these cases; moreover, it has served admirably in differentiating between those cases that should be treated medically and those wherein surgical treatment is indicated. In his experience surgery has been confined to those cases in which there was delayed elimination of the dye beyond the normal time limit, or none at all. Regarding the case of carcinoma of the ureter he understood Doctor Herman to say that the dye was eliminated in twenty-five minutes from the right kidney and in sixteen minutes from the left or affected side. Apparently there was no involvement of the kidney whatever—the lesion, a carcinoma, was confined to the ureter. Seemingly, there was no obstruction of the ureter on that side and, therefore, no interference with the elimination of urine from that kidney. He did not see,

therefore, why any interference with the function of that kidney should have been suspected.

DR. LLOYD B. GREENE said that there is a fairly characteristic pyelogram in papilloma of the renal pelvis. There are certain factors that make the diagnosis speculative. The most common are blood clots and stone, but by repeated examination these may be eliminated as a source of error. Since pyelography is being done so much more frequently now than even a few years ago and the specialty of urology is advancing so rapidly a positive diagnosis will probably be the rule rather than the exception in the future.

DR. GEORGE P. MULLER said that Doctor Herman referred to the case which Doctor Bothe will report in detail. The patient was fifty years of age, had no symptoms until August, 1928, when he had an attack of acute bladder pain, passed more clots, at which time he came under our observation. Doctor Bothe made a pyelogram and diagnosed papilloma of the pelvis of the kidney. Nephrectomy was performed. When the pelvis was exposed it was felt to contain a growth about the size of a walnut. Perhaps he should have opened the pelvis of the kidney, and if it were found benign, have snared the base, but Doctor Bothe and the speaker felt it was a malignant condition and that a nephrectomy had better be done. The man was well when last heard from, one week ago.

DR. THOMAS G. STELLWAGEN said that Doctor Herman almost persuades him to believe that the diagnosis of tumor of the pelvis of the kidney can be made by pyelogram. The speaker felt, however, that in the vast majority of cases it was guessing. Doctor Stellwagen has had a fair number of cases of papilloma and has been able to diagnose a few of them. Some, which were diagnosed as papilloma, turned out to be hypernephroma, some to be stone, and so it went. He ran the gamut of the usual misinterpretation of pyelograms. He makes it a matter of routine to radiate these patients previous to operation and then again after operation. The speaker recalled definitely three cases of malignant growths of the kidney which are well and alive today. One of whom he saw recently has gained twenty-two pounds in weight and has had no symptoms whatever.

DR. ASTLEY P. C. ASHHURST asked whether it is common to have profuse hæmorrhage in growths of the renal pelvis which are only microscopical in size. He had a patient with hæmaturia, in whom the pyelograms were practically negative, and at operation removed what seemed to be a normal kidney, on the assumption that a small tumor was bleeding into the pelvis. The pathologist, Dr. C. Y. White, examined the specimen very carefully, but only after cutting it up into mincemeat did he finally find an area which he thought looked abnormal. On microscopical examination he found this was a hypernephroma bordering on the pelvis. The patient has been entirely free from hæmaturia since the operation.

DR. HENRY P. BROWN, JR., recalled a case in the service of the late Dr. Robert LeConte in which the diagnosis was essential hæmaturia. On

account of persistent bleeding Doctor LeConte decided upon nephrectomy. Section of kidney revealed, in the upper pole of the cortex, an area approximately five millimetres in diameter, which under the microscope proved to be early tubular carcinoma.

Dr. Leon Herman, replying to Doctor Ashhurst's question, said that massive hæmaturia from a hypernephroma of microscopic size would seem to be unlikely, and yet considerable renal bleeding occurs not infrequently in the absence of adequate demonstrable cause. In many instances we are compelled in the absence of demonstrable pathology, to classify these cases as idiopathic or essential hæmaturia. This is a hazardous diagnosis, but a necessary one in some instances. It should always be a tentative one, however, and adhered to only as long as repeated examinations fail to disclose a real pathological cause of bleeding. Excessive hæmaturia may necessitate nephrectomy in a few of these cases.

The diagnosis of intrapelvic tumors is difficult, but the speaker cannot agree with Doctor Stellwagen and Doctor Thomas that pyelography is of little or no aid. The pictures which we have shown were of great assistance and, as experience grows, we will be able, no doubt, to standardize the defects produced by these tumors just as we have been able to do with the more common lesion of the kidney. A normal pyelogram of the bleeding kidney does not remove the possibility of an early neoplasm.

## SCROTAL DRESSING

Dr. Thomas Stellwagen said that for some years past he had been evolving a surgical dressing for the scrotum and felt that it was sufficiently perfected to offer it to the profession. It eliminates many of the inconveniences formerly encountered. It is readily applied and stays where put when properly constructed. Further, it permits evacuation of the bowels without disturbing the dressings and makes possible the use of the enæma or colonic tube for irrigation without soiling of the operative area. In the past he has used the perineal "T" binder and the crossed spica of the perineum. The binder was unsatisfactory as it did not give the proper support to the scrotum. In the post-operative tossing of the patient, it frequently became displaced and permitted exposure of the operative field. It also necessitated removal of the dressings when the toilet was attended to, etc. The crossed spica is an excellent dressing, but difficult to apply and frequently uncomfortable. To put it on properly the patient must be raised in bed upon an elevator. This is uncomfortable and often distressing. Again, whenever the case is dressed the entire procedure of application of a new bandage must be gone through with. The scrotal sling that the speaker described obviates these difficulties.

It consists of a bridge of adhesive plaster, sometimes spoken of as a "Bellevue bridge", with modifications and additions as shown in the diagrams. Before applying the sling or bridge, the anterior surfaces of the thighs should be cleanly shaved and wiped with sponges saturated with ether to

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_____ . __ _____ ___ . .

ADHESIVE SIDE OF PLASTER

C

B·

D · · ▪··· · · · · · D

C
C
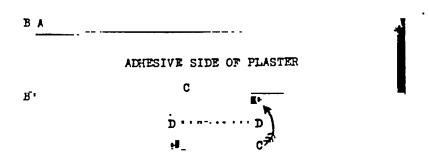
FIG. 1.—Pattern as cut from the adhesive plaster roll. Measure the distance from the outer side of each thigh with patient on back and legs in a comfortable position. Length of the scrotum should be allowed for. A-A thigh distance; B-B the scrotal length; C-C-C-C lip to be folded upon itself along D-D.
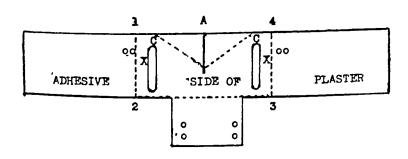
FIG. 2.—Stages in the preparation of the dressing.

facilitate adhesion of the plaster to the skin. It is further important to use fresh adhesive plaster to insure good retention of the dressing.

A straight cut is made from one-third to one-half of the width of the bridge at the line A-A. The two triangular corners, A-A-C, are then turned down on the adhesive side and pressed fast. This forms a notch for the perineo-scrotal junction, thus making a close fit to the perineum which is very essential. The next step is to cut two spreaders from wood tongue depressors and press them fast to the adhesive surface at X and X. These keep the dressing well stretched and prevent subsequent wrinkling. The area within the figures 1, 2, 3, 4, is then covered, sticky side to sticky side with adhesive plaster and ironed



Fig. 3.—The bridge applied; A-A strips of adhesive plaster used to tack down the lower angles of the plaster. The tension of the tapes when tied over the gauze dressings tends to raise these angles.

down tight over the spreaders. It is notched out at the perineo-scrotal point to conform to the pattern. Double holes are then snipped by curved scissors at the points marked oo and tapes of proper length are tied into them.

The dressing is best applied as follows: The scrotum is raised upward and backward upon the abdomen as far as possible. While in this position the bridge is applied, making sure to get the perineo-scrotal-notched area snugly intact with the perineum. In this position the thigh flaps are then applied with proper tension on this



Fig. 4.—Dressing in place.

bridge. The final step in the dressing is to use a fairly large piece of rubber dam with a hole for the penis to project through. This largely prevents soiling of the dressings by urine.

# BOOK REVIEWS

I. SURGERY IN THE TROPICS, by SIR FRANK POWELL CONNOR., Sm. oct., cloth; pp. 293. Philadelphia, P. Blakiston Son & Co., 1929.

Here is a little book from the professor of surgery in the Medical College of Bengal. It is attractive in its make-up and convenient in its form, not too big to be slipped into one's pocket, or to be thrown into one's kit bag. It is true that many of the subjects of which it treats can rarely come into the experience of a surgeon practicing in a temperate climate, nevertheless, it is quite evident that in the future, the rapid overcoming of the bar of distance in separating mankind will make the diseases peculiar to the tropics to come much more frequently within the scope of the practice of the temperate zones. This book of Connor does not pretend to be a textbook of tropical medicine nor a treatise on general surgery, but confines itself to those special aspects of surgery and surgical diseases which are peculiar to the tropics. To this field the author has confined himself with admirable discretion. The manner in which he has treated his subject is peculiarly engaging. One feels, as he turns its leaves and reads its paragraphs, that he is talking with a man who is relating to him what he himself has seen and describing things with which he is personally familiar. There is a certain chumminess, if I may be permitted the term, about the book which makes its reading especially interesting. We note the claim that although the conditions of life in the tropics, including, as they so often do, heat, dust, dirt, and uncleanly habits, provide peculiar opportunities for septic infection, nevertheless, in spite of these difficulties, the practice of surgery has been raised by tropical surgeons to almost as high a degree of perfection as in western countries.

The author begins with staphylococcic infections. No one who has spent any time in tropical regions will dispute the importance and prevalence of such infections, though in their simple elements comparatively slight, yet in their diffusion sources of great annoyance and even of danger to life. Speaking of boils, we can imagine our New York colleague, Theodore Dunham, who, in 1919, described before the New York Surgical Society an original method of treating boils by perforating the focus of each boil by the eye-end of a needle dipped in carbolic acid, reading now, ten years later, the statement of an East Indian surgeon that a very efficient method of treatment of boils is "the drilling of each boil by the sharpened end of a match or probe of ivory dipped into pure carbolic acid". It is to be hoped that there will not arise any ill-natured discussion as to priority in the matter!

One cannot but be interested in the statement that tuberculosis is one of the commonest diseases in the tropics and gives rise to an enormous mortality. This, the author thinks, can be explained largely by insanitary surroundings and lowered resistance due to heat, acting with many special causes. As to

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syphilis, the author draws attention to the enormous incidence of the disease in the tropics but does not enter into any extended discussion. More room is given to the discussion of that closely related disease, frambœsia or yaws. We are assured that, although the organism which produces yaws is morphologically indistinguishable from that of syphilis and that the Wassermann reaction is positive in both diseases, their differential diagnosis is not difficult. Yaws is a less serious disease than syphilis and is much more amenable to treatment. Although mercury is ineffective against yaws, the salvarsan derivatives and bismuth preparations are very useful. The various granulomata, actinomycosis, Madura foot, mossy foot, and blastomycosis are mentioned more or less fully. The surgical aspects of the dysenteries receive the largest share of attention of any one subject in the book. Amœbic dysentery, the dysenteries caused by the bacillus of Shiga and of Flexner and that due to Bilharzia infection are each quite fully discussed, including necessarily the subject of amœbic hepatitis and liver abscess. Then comes the engrossing subject of filariasis. The filariæ of Bancroft are responsible, the author states, for surgical lesions, the multiplicity and importance of which can hardly be exaggerated. What malaria means to the tropical side of medicine, filaria means to the surgical side, being comparable with spyhilis as regards its widespread incidence and the variety of infections produced. Here are introduced the numerous complications of diseases of the lymphatic system with chylous effusions into serous cavities and elephantiasis of various portions of the body whose lymphatic circulation becomes obstructed. Various affections due to parasitic insects, intestinal parasites and snake-bites close the volume.

That which gives the greatest interest to the book is the colloquial style in which it is written, and as one closes the volume and lays it down, one has the sensation of having spent the evening in talk with one who has had a personal knowledge of the things he has been talking about and who knows how to talk about them in an interesting and instructive manner.

II. The Mobilization of Ankylosed Joints by Arthroplasty. By W. Russell Macausland, M.D., and Andrew R. Macausland, M.D., oct.; cloth; pp. 252. Philadelphia, Lea and Febiger, 1929.

Operations for the purpose of restoring mobility to ankylosed joints belong to the new school of orthopedic surgery and are among its most important and finest achievements. Yet one reads with interest of the operations of Barton, in Philadelphia, as long ago as 1826 for the relief of an ankylosis of the hip-joint, in which an osteotomy through the great trochanter and part of the femoral neck was done. The subsequent manipulations were successful in preventing recurrence of the ankylosis for two years when it recurred. Rodgers, of New York, in 1840 improved Barton's method by removing a disc of bone from between the trochanters with the result of securing permanent mobility to the joint. Reports of occasional efforts of this kind for restoring mobility to ankylosed joints by the Rodgers' method appear from time to time from the first effort of these earlier surgeons mentioned to the

period of the introduction of antiseptic methods into surgery, culminating in the well-known treatise of Ollier on "Resections and Conservative Operations on Bones" in 1885.

This book by the Boston surgeons presents to us an excellent study of the general subject of ankylosis of joints and the possibility of relief by arthroplasty as developed and perfected to present time by the efforts of the surgeons of all countries. The reviewer remembers with pleasure the enthusiasm of the lamented Murphy of Chicago in this line of work and particularly the results obtained by him in arthroplasty of the hip-joint. It is pleasant to see that the authors of the work under review give proper credit to the Chicago surgeon for his masterly labors in this field.

The authors do not claim that arthroplasty can restore a joint to its normal condition. The most they claim is that in many cases "it creates an articulation that is as satisfactory from the point of view of service and function as is the normal joint. The new joint has stability; it is strong; it adapts itself to weight-bearing and its nicety of motion makes the limb a functional and serviceable member." Such is the claim of the authors. The reviewer, however, is inclined to think that such a claim is a little too enthusiastic and that rarely is the ultimate result secured by arthroplasty which fulfils all these claims, although a fairly satisfactory joint is often secured; one that is an immense improvement over the disabling ankylosis previously existing.

Each joint in succession is taken up for consideration and detailed methods of mobilizing procedures are described and abundantly illustrated. The book as a whole is an extremely practical one and may be accepted as an authoritative statement of the present condition of the surgery of ankylosed joints.

DISEASES OF THE THYROID GLAND. By ARTHUR E. HERTZLER, M.D. Second edition; large octavo; cloth; pp. 286. St. Louis, The C. V. Mosby Company, 1929.

The author published the first edition of this book in 1922 as a contribution giving the result of observations and studies in a small country hospital somewhat isolated and providing material which could be followed up in a large proportion of cases to their end results. The author then stated that the study of his cases had convinced him that statistics hitherto published were of little value. They presented the disease in too optimistic a light and a great overestimate of the permanent value of any treatment. He now presents this new edition as a continuation of the studies contained in the previous one. Many of his patients he has been able to follow for more than thirty years and is able to present conclusions arrived at that are of value, arrived at only after constant comparison of clinical pictures and pathology ascertained by repeated examinations in after years.

The text is very excellently illustrated by a large number of cuts, one hundred and fifty-nine in all. In the book itself, a consideration of the normal morphology of the thyroid gland is followed by a full discussion of the pathological anatomy of tumors of the thyroid gland. This chapter on pathol-

ogy occupies more than one third of the pages of the book. It is well written; its teachings are clear and as a whole, it is an excellent résumé of present knowledge of the pathology of the various tumors of the thyroid gland.

The matters of symptomatology and diagnosis receive due attention. The pages devoted to goitres in unusual places are especially instructive. A chapter on hospital management of goitre patients is contributed by Dr. Victor E. Chesky. The last fifty pages of the book are taken up with the consideration of operative attacks upon the gland. The text here is especially well illustrated. One is impressed, however, with the feeling that the author does not err on the side of being too conservative in his work. The possibilities of injury to the recurrent laryngeal nerve or the removal of parathyroid bodies receives mention but with a lack of emphasis that hardly comports with the importance of the injuries or the real difficulties with which, in many cases, such injuries are avoided. Myxedema caused by removal of too much thyroid tissue receives brief mention qualified by the rather emphatic statement that "it has been repeatedly proved that only a small amount of thyroid tissue with sufficient blood and nerve supply is adequate to carry on normal function of the gland." One would like to have had the opinion of the author with his large experience as to just how much thyroid tissue the less experienced surgeon should plan to leave behind him in any operation upon the thyroid gland. The book, as a whole, is an excellent, practical treatise upon the subject to which it is devoted.

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LEWIS S. PILCHER, M.D.
*Brooklyn, N. Y.*

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